Draft Final

BEAR GULCH MINE COMPLEX
ENGINEERING EVALUATION/COST ANALYSIS
IDAHO PANHANDLE NATIONAL FORESTS
SHOSHONE COUNTY, IDAHO

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March 2003

EXECUTIVE SUMMARY

Maxim Technologies, Inc.® (Maxim) prepared this Engineering Evaluation/Cost Analysis (EE/CA) for the United States Department of Agriculture Forest Service (USDA-FS). This report presents an engineering evaluation and cost analysis of alternatives for potential cleanup of waste rock and tailings present at four mines and a former mill site in the Bear Gulch Mine Complex, which is located on the Idaho Panhandle National Forests in the Summit Mining District, Shoshone County, Idaho.

The Complex contains five historic gold, silver and lead mines that produced ore during the period from 1904 to 1983. Mining was conducted underground on patented claims, and mining wastes in the form of waste rock and mill tailings were deposited on private land and adjacent National Forest System lands. The USDA-FS is contemplating the cleanup of mining waste present at the mine sites and mill on National Forest System lands under their Superfund authority.

Mining wastes located on the site present potential human health and environmental impacts to forest users. Potential human health and environmental impacts addressed in this document are associated with elevated levels of heavy metal contaminants that are present in a waste rock dumps and tailings.

Based on data presented in a Site Investigation Report, the Bear Gulch Mine Complex likely impacts water quality. Water quality impacts result principally from mine waste present at the Bear Top/Orofino Mill Site. These wastes are in direct contact with the creek along the streambanks, in the streambed, and on adjacent areas along the stream. Five adit discharges present at the mine sites exhibit limited flows (less than one to four gallons per minute) but the near-neutral pH discharges contain concentrations of cadmium, lead, and zinc that exceed State of Idaho acute and chronic water quality criteria.

In Bear Gulch Creek sediment, total lead and zinc concentrations increased through the Complex, indicating that the Bear Top/Orofino Mill Site and possibly the other mines in the Bear Gulch Mine Complex negatively impact sediment quality in Bear Gulch Creek.

In mine waste, cadmium, copper, lead, mercury, and zinc are elevated above background concentrations. The one common contaminant of concern (COC) present at all but one of the 17 mine waste areas is total lead. Concentrations of total lead in nearly all mine waste samples exceeded 1,100 mg/kg, well above background levels. The maximum total lead concentration was 116,000 mg/kg in tailings. Leachate tests conducted on mine wastes indicated that the metals present in the waste are leachable, with lead and zinc being the most common leachable metals. Leachable metals concentrations were commonly measured above State of Idaho chronic aquatic life standards.

Contaminants are released from waste rock and tailings into the environment by several mechanisms. Precipitation infiltrates the tailings and waste rock and leaches contaminants into underlying soil and groundwater. In at least one portion of the site, the base of tailings is in direct contact with groundwater. Bear Gulch Creek flows through tailings, which facilitates dissolution of contaminants and erosion.

Exposure pathways to humans and animals appear to be primarily related to direct contact or ingestion of contaminants. Current risks to humans on National Forest System lands are believed to be limited to recreationists. Ecological receptors of contaminants may include aquatic organisms and animals drinking from Bear Gulch Creek.

A streamlined risk evaluation for the site demonstrated that the Bear Gulch Mine Complex presents both human health and ecological risks from metals in mine waste. For human health risk, lead is the only COC that exhibits concentrations that could cause elevated levels of lead in the blood of adults and children. The human health risk primarily results from exposure to lead through ingestion; dust inhalation does not appear to be a problem, as the mine wastes in the Complex are predominantly coarse grained. For ecological risks, zinc is present in surface water at concentrations that exceed chronic aquatic water quality criteria, cadmium, lead, and zinc are present in sediment in concentrations that could pose a risk to aquatic organisms, and lead and zinc are present in soil at concentrations that could impact terrestrial biota.

The scope of a proposed removal action at the Complex is limited to reducing or eliminating uncontrolled releases of metals from mine tailings and waste rock. Addressing environmental impacts associated with mill tailings and waste rock, regardless of whether the wastes are removed or controlled in-situ, will mitigate the movement of metals from the site into the surrounding environment, disrupting the direct release pathway that allows metals to migrate into site soil and water unchecked. A removal action that addresses mill tailings and waste rock present within the Complex presumes that some attendant reduction in contaminant concentrations will occur in surface water, groundwater, and stream sediment as a result of removing or controlling the primary source of contamination.

The scope of this initial removal action does not include control or treatment of mine discharges and does not directly address contamination of groundwater resources that may be impacted by mine discharges. While these problems may be addressed in future removal actions at the site, monitoring the effectiveness of the initial removal action would be the primary basis to determine if any future removal actions are necessary.

Preliminary removal action objectives for the project include the following:

- Reduce or eliminate safety hazards
- Reduce or eliminate human health hazards associated with metals contamination
- Reduce or eliminate hazards presented by sediment and metals contamination to the stream in Bear Gulch
- Improve aquatic health and habitat

Four removal action alternatives were developed for detailed analysis. Alternatives were assembled by combining process options so that each alternative either offered a distinct benefit over another alternative or provided a different approach to meeting project objectives. A brief description of each of the alternatives is presented below.

1. *No Action* - No action requires no removal, treatment, or containment of waste. Site conditions remain unaltered and risks to human health and the environment persist.

2. *Improve Vegetation on, and Limit Access to, Waste Rock Dumps* – This alternative involves improving vegetation on and restricting access to the waste rock dumps by closing roads and trails.

3. *Consolidate Tailings out of the 100-Year Floodplain, Improve Vegetation on, and Limit Access to, Waste Rock Dumps* – Tailings will be consolidated on-site in an area located on the north side of Bear Gulch above the 100-year floodplain. Vegetation on waste rock dumps would be improved and roads and trails would be closed in accordance with Alternative 2.

4. *Remove Tailings and Accessible Waste Rock to a Central Repository; Improve Vegetation on, and Limit Access to, Waste Rock Dumps* – Tailings and waste rock will be removed to a central repository located about 12 miles northwest of the Bear Gulch Complex. Waste rock would be removed from the accessible dumps at the Orofino and Silver Scott Mines. Vegetation will be improved on inaccessible waste rock dumps and access to the dumps will be restricted by closing roads in accordance with Alternative 2.

Alternative 4, removal of tailings and waste rock to a central repository, is the most effective of the alternatives evaluated in detail. Under this alternative, 41% of the volume of waste present in the Complex is removed, and exposure to humans and the environment are controlled by covering with soil in an engineered facility. In addition, 80% of the area of exposed waste is reclaimed, eliminating a substantial portion of the direct exposure and ingestion risk from mine wastes in the Complex. Residual risk at the inaccessible waste rock dumps is reduced to an area of about one acre, and exposure to lead in these wastes is further reduced to humans by closing roads and trails that lead to these wastes.

Alternative 3, consolidation of tailings outside of the 100-year floodplain is less effective than Alternative 4 because accessible waste rock would not be removed. However, 67% of the area covered by COCs in the Complex (about 3.2 acres) is reclaimed, and tailings, mixed tailings, and concentrates that contain the highest concentrations of COCs are covered, preventing direct contact and ingestion pathways to humans and wildlife. Residual risk from lead remains at the waste rock dumps, but exposure to lead in these wastes is reduced to humans by closing roads and trails that lead to these wastes.

Alternative 2, which improves vegetation on waste rock dumps in order to promote slope stability and reduce downslope movement of the wastes, is the least effective of the alternatives evaluated because these wastes are not removed, covered, or treated. Therefore, reductions in exposure of humans to lead in these wastes is fully dependent on closure of roads and trails, and only minor reductions in metal mobility can be realized. Exposure of COCs in the wastes to wildlife is essentially the same as current conditions under this alternative.

Safety risks would be decreased by all the alternatives through closure of open adits and stopes, and closure of all roads and trails accessing the waste dumps. Residual risk remains from metals released by adit discharges under all the alternatives.

Alternative 2 has the least short-term impacts to the area because it can be constructed in the shortest time with the least amount of equipment, and confines nearly all the impacts that result from removal action construction to within the Complex. Alternative 2 requires only minimal road upgrades compared to the road upgrades needed to implement Alternatives 3 and 4, and requires much less travel on local highways. Short-term impacts associated with Alternative 4 places the most impacts on local roads as a large number of truck trips would be made to haul waste to the USDS-FS repository, and an equally large number of truck trips would be required to haul backfill needed to reconstruct the tailings removal area. Short-term impacts associated with Alternative 3 are about the same as Alternative 4, as backfill would still be hauled from either a near-by source or the USDS-FS repository to Bear Gulch, but these impacts would occur over a shorter period of time. As a result, Alternative 4 poses the greatest risk to people and wildlife from potential vehicular accidents.

Alternatives 3 and 4 have are the most likely of the three alternatives evaluated to comply with ARARs, including contaminant-specific numeric standards. Alternatives 3 and 4 may also comply with action-specific ARARs because a majority of the wastes adjacent to the flowing surface water in Bear Gulch will be removed. Alternative 2 will not meet these same ARARs because only a portion of the wastes present will be stabilized, leaving the tailings untreated. Although adit discharges do not meet water

quality criteria currently, the relatively low flows are not believed to affect water quality in Bear Gulch Creek, and all three alternatives will minimize flows at the surface, thus reducing risks of exposure of the discharges to humans and wildlife.

All alternatives are technically and administratively feasible. Essential project components such as equipment, materials, and construction expertise are available. However, under all three alternatives, improving vegetation on waste rock dumps may be difficult on steeper and less roaded areas of the Complex (e.g. Upper Orofino and Upper Ione Mines) and difficulties with implementability may be encountered. Construction elements associated with Alternatives 3 and 4 may also be difficult to implement, especially associated with removal of tailings and diversion of surface water flow in Bear Gulch around the tailings removal and stream reconstruction area.

Alternative No. 4, removal of tailings and accessible waste rock to a central repository is the most expensive of the evaluated alternatives. The total cost to implement this alternative is about $2.5 million. This cost is about $0.93 million higher than the Alternative 3 cost of 2.37 million. The estimated cost for Alternative 2 is $410,000, and the cost for No Action is about $2,500 annually for monitoring, which equates to a present-worth cost for 30 years of $47,000.

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1.0 INTRODUCTION

Maxim Technologies, Inc. (Maxim) developed this Engineering Evaluation/Cost Analysis (EE/CA) for the United States Department of Agriculture Forest Service (USDA-FS) under the terms and conditions of Contract No. 53-0343-0-0014 (CERCLA/RCRA Services). This report presents an engineering evaluation and cost analysis of alternatives for potential cleanup of tailings and waste rock present in the Bear Gulch Mine Complex (Complex), which is located on the Idaho Panhandle National Forests in the Summit Mining District, Shoshone County, Idaho (Figure 1).

The Complex contains five historic gold, silver and lead mines that produced ore during the period from 1904 to 1983. Mining was conducted underground on patented claims, and mining wastes in the form of waste rock and mill tailings were deposited on private land and adjacent National Forest System lands. The USDA-FS is contemplating the cleanup of mining waste present at the mine sites on National Forest System lands under their Superfund authority (Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Section 106), which allows the USDA-FS to respond to the release or threat of release of hazardous substances on lands under its jurisdiction or lands impacting its jurisdiction.

Mining wastes located in the Complex present potential human health and environmental impacts to forest users. Potential human health and environmental impacts addressed in this document are associated with elevated levels of heavy metal contaminants that are present in tailings and waste rock.

1.1 PURPOSE AND OBJECTIVE

This EE/CA was developed by following the "non-time-critical removal" process outlined in CERCLA, as amended, and the updated National Oil and Hazardous Substances Pollution Contingency Plan (NCP). A non-time-critical removal action is implemented by the lead agency to respond to "the cleanup or removal of released hazardous substances from the environment… as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare or to the environment…" (U.S. Environmental Protection Agency [EPA], 1993). Following EPA's *Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA* (EPA, 1993), the EE/CA provides the logic and process to screen, develop, and evaluate potential response alternatives that may be used to cleanup mining wastes. The objective of the EE/CA is to develop potential alternatives for engineering and cost parameters that could be employed to reduce or eliminate potential human health and environmental risks that are associated with open adits, waste rock, and tailings in the Bear Gulch Mine Complex.

1.2 PROJECT BACKGROUND

The USDA-FS and the Idaho Geologic Survey (IGS) entered into an agreement in 1992 to inventory abandoned and inactive mines on or affecting National Forest lands in Idaho. Inventorying, cataloging, and limited mapping were completed by the IGS in 1993. In 1996, the IGS performed field examination of all mines in the Bear Gulch Mine Complex. Surface water and solid samples were collected at the mine and results are reported in IGS (1997).

In 2001, the USDA-FS contracted with Maxim to further characterize mine wastes and to estimate volumes of various mine waste materials at five mine sites in the Bear Gulch drainage. Potential environmental impacts from historic hard rock mine/mill wastes present at these sites include potential increases in sediment load to surface water, increases in metal concentrations in surface water and groundwater, and health and safety risks. Maxim completed field studies in 2001 and 2002 and generated data to support mine waste removal decisions for the Bear Gulch drainage. Results of the

site investigation are presented in Maxim (2003), *Site Investigation Report, Bear Gulch Mine Complex, Summit Mining District, Idaho Panhandle National Forests, Shoshone County, Idaho.*

1.3 REPORT ORGANIZATION

This EE/CA is organized into eight sections. Following this introductory section, a brief description of the site is presented in Section 2.0. An overview of pertinent findings from IGS (1997) and Maxim (2003) is presented in Section 3.0. Section 4.0 is a streamlined evaluation of the potential risks posed by mining impacts to human health and the environment.

Section 5.0 outlines the removal action scope, proposed removal action objectives (PRAOs), and goals for the site. The PRAOs were developed in consideration of applicable or relevant and appropriate requirements (ARARs) and results of the streamlined risk evaluation. Final RAOs will be prepared after consultation with the USDA-FS interdisciplinary team. Proposed applicable clean-up standards and guidelines are also presented in Section 5.0.

In Section 6.0, reclamation technologies and process options are discussed and screened, and potentially applicable removal alternatives are developed. Section 7.0 presents a detailed analysis of alternatives using NCP evaluation criteria. Section 8.0 compares the alternatives against three primary criteria – effectiveness, implementability, and cost. Figures and tables are incorporated into the text of the report. References cited in the document are listed in Section 9.0. Appendices that contain supporting documentation are included at the end of the document.

2.0 SITE DESCRIPTION

The Bear Gulch Mine Complex (Complex) is situated in the Summit Mining District (District) and is comprised of five sites. Mine waste materials at the Complex are located on both private and National Forest System lands. Table 1 summarizes pertinent site information for the five mines in the Complex and Maxim (2003) contains detailed descriptions of each site.

2.1 SITE LOCATION AND DESCRIPTION

The Complex is situated in the Summit Mining District in the central portion of Shoshone County, approximately seven miles east of Murray, Idaho (Figure 1). The District is one of eleven districts that are collectively known as the Coeur d'Alene Mining District. The five mine sites are located in the Coeur d'Alene River Ranger District of the Idaho Panhandle National Forests, and are situated within the Bear Gulch Drainage. Access to the area is by Forest Service (FS) Road 9, which follows the North Fork of the Coeur d'Alene River from the Kingston exit off Interstate 90 to Thompson Pass. Thompson Pass can also be accessed seasonally from Thompson Falls, Montana, by traveling west on Forest Highway 9. Access to the five mine sites in Bear Gulch is by gravel road FS Road 938, which intersects Forest Highway 9 about seven miles west of Thompson Pass (Figure 1).

Site information including the legal location, ownership, cultural features, mine openings, waste material areas, and surface water observations for each site within the Complex is summarized in Table 1. The study area is shown on a July 10, 1996 aerial photograph of the drainage on Figure 2. Private property boundaries are shown on Figure 3.

The Bear Top/Orofino Mill Site is located in the bottom of the Bear Gulch drainage, a tributary to Prichard Creek. The Bear Top, Orofino, and Ione Mines are located on the south side of the Bear Gulch drainage, while the Silver Scott Mine is located on the north side. Site elevations range from about 3,600 feet above mean sea level (amsl) at the mill site to approximately 5,500 feet amsl at the Ione Mine. The area is heavily forested with dense brush and conifers, and the topography is generally very steep. Access to the Bear Top Mine workings, the upper workings at the Orofino Mine, and the lower and middle Ione Mine workings is difficult and currently limited to all-terrain vehicles. The only access to the upper Ione Mine workings is by trail. Road access to the mines is on very steep grades with numerous switchbacks.

A central mine waste repository location has been selected by the USDA-Forest Service for wastes removed from National Forest lands within the Prichard and Beaver Creek drainages, which includes the Bear Gulch Mine Complex. The central repository, the Prichard/Beaver repository (USDS-FS repository), is located approximately 12 miles northwest of the Complex, north of FS Road 152 and south of FS Road 3019 (Figure 1).

2.2 MINING HISTORY

Most of the mines in the Summit District are base metal (lead and zinc) shear zone-hosted deposits within metasedimentary rocks of the Precambrian aged Belt Supergroup. The history of each site within the Complex is summarized below. Mining activities began as early as 1904 (BearTop/Orofino Mill Site) and discontinued as recently as 1983 (Silver Scott Mine).

Table 1 – Site Information Summary

2.2.1 OROFINO MINE

The inactive Orofino Mine was consolidated with the Bear Top Mine in 1911, with the most recent recorded operations noted in 1954. Lessees reclaimed the dump in 1955. The Orofino Mine is located directly down slope from the Ione Mine and its two levels exposed a vein that strikes from N 60° W to 80° E and dips from 50° to 60° S. At the two levels, four waste rock dumps and two discharging adits are present. Production figures for the Orofino are not available, but considering the size of the waste rock dumps, this mine was probably the largest producer in the Bear Gulch Complex.

2.2.2 SILVER SCOTT MINE

The Silver Scott Mine has been operated as recently as 1983. The mine site includes two waste rock dumps and two open adits. The lower adit seeps and has a timbered portal. Heavy gauge rail tracks lead from the adit to a collapsed loading platform in front of the portal. The upper adit is located approximately 150 feet up-slope from the lower adit and dump area. The upper adit is dry and its associated waste rock dump is iron stained with a heavy sulfur smell (IGS, 1997). This adit was probably driven on the vein and the waste dump contains sulfides.

2.2.3 BEAR TOP/OROFINO MILL SITE

The Bear Top/Orofino Mill Site was built in 1904 on the active waterway of Bear Gulch Creek, producing jig tailings as a waste product. The water powered mill structure consisted of a flume, compressor, crusher, rollers and jigs, concentrator, and a 3,000-foot aerial tramway connecting to the No. 3 level of the Bear Top Mine. Original mill capacity was 60 tons per day, which was later upgraded several times with the advent of electric power to a peak capacity of 150 to 200 tons per day. The mill site was operated intermittently until the mid-1930s producing "first-class" smelting-grade ore (IGS, 1997).

2.2.4 BEAR TOP MINE

The Bear Top Mine was operated intermittently from the early 1900s until as recently as 1977. The three working levels include 5 open adits, 2 stopes and several waste rock dumps (Maxim 2003). Total recorded production for the Bear Top Mine between 1904 and 1973 was 22,070 tons of ore yielding 19 ounces of gold, 23,794 ounces of silver, 7,242 pounds of copper, 6,500,000 pounds of lead, and 237,000 pounds of zinc (IGS, 1997).

2.2.5 IONE MINE

The Ione Mine was discovered in 1908 (IGS 1997). Nothing more is mentioned about the Ione Mine until 1922/1923 when the Ione Mining Company developed the workings. The most recent operations occurred at the mine in the 1970s. Three working levels are present with four waste dumps and associated adits. No mention of the mine is made after 1980. No production records are available for the Ione Mine; however, from available information, it appears output from this mine was small.

2.3 GEOLOGY

The Idaho Geological Survey (IGS 1997) presents a summary of the geologic framework of the Summit Mining District. The principal references to the geology and ore deposits of the Summit Mining Districts are Hosterman (1956) and Shenon (1938).

The host rocks for most of the ore bodies mined in the District are the metasedimentary rocks of the Precambrian age Belt Supergroup. Most important for the mines in the district is the Prichard Formation, which is classified into upper and lower parts (IGS 1997). Most of the lode mines in the area are hosted in Hosterman's lower Prichard unit, which consists of banded medium-gray argillite with abundant pyrite crystals.

The primary mineralization in the Summit Mining District occurs along faults and shear zones that cross bedding at steep angles. Mineralization noted in these structures includes pyrite, magnetite, chlorite, carbonate, quartz, pyrrhotite, sphalerite, galena, and latite quartz (IGS 1977).

2.4 HYDROLOGY

The study area is located within Bear Gulch drainage, a tributary of Prichard Creek which discharges into the Coeur d'Alene River at Prichard, Idaho (Figure 1). The Bear Top/Orofino Mill Site is situated within the Bear Gulch floodplain. Several unnamed tributaries of Bear Gulch are proximal to the four mine sites (Figure 2). Waste rock dumps are located adjacent to tributary streams at the Silver Scott Mine and the Orofino Mine (Figure 2). Tributaries to Bear Gulch are ephemeral and appear to exhibit peak runoff during spring months.

Groundwater occurrence and flow in the Bear Gulch drainage has not been studied. Due to the steep, narrow bedrock valleys, alluvial aquifers are likely thin, discontinuous and confined to the valley bottoms. The metasedimentary rocks in the study area are faulted and fractured (IGS 1997) and groundwater occurrence and flow are likely controlled by the orientation and interconnectedness of fracture systems. Bedrock aquifers apparently sustain baseflow in Bear Gulch Creek and are an important contributor to other surface water flows in the study area.

3.0 SUMMARY OF SITE INVESTIGATION RESULTS

Two site investigations have been conducted in the Bear Gulch Mine Complex for the USDA-FS. The IGS conducted the first site investigation in 1996 (IGS, 1997). Samples collected during the IGS investigation included two water samples at the Orofino Mine, background water quality samples from several tributaries of Prichard Creek (including Bear Gulch Creek) one tailings sample from the Bear Top/Orofino Mill Site, and one waste rock sample from the Silver Scott Mine. Maxim conducted a more detailed site investigation at the Complex in 2001 and 2002 (Maxim, 2001; 2003). This investigation resulted in the collection of 54 mine waste samples, seven water samples, and two sediment samples.

A summary of safety hazards, surface water quality, sediment quality, adit discharge quality, and mine waste characteristics from the two site investigations is presented in this section. More detailed information can be found in the reports of these site investigations, which are referenced above and listed in the reference section of this report. Table 2 lists pertinent background concentrations of metals and major ions that are typical of soil and rock in the area. Idaho's acute and chronic aquatic life standards for metals in water are also shown, along with the National Oceanic and Atmospheric Administration (NOAA) probable effects levels (PELs) for sediment (NOAA, 1999). These data will be used for comparison purposes in subsequent discussions of site investigation results.

3.1 SAFETY HAZARDS

Safety hazards are defined as mine openings that allow unrestricted access to underground mine workings, holes or other openings that are greater than 15 feet deep without entry prevention devices at the surface, holes or openings that have steep side slopes that prevent self-extraction, and unsafe structures. Safety hazards were identified at each of the five mine sites. These hazards include open adits, open stopes at the Bear Top Mine, and collapsed or dilapidated buildings. The most significant hazards are the open adits and stopes. Mine opening sizes and a topographic map of the large stope at the Bear Top Mine are available in Maxim (2003).

3.2 SURFACE WATER QUALITY

With the exception of one sample collected from the main stem of Prichard Creek by the IGS, all background surface water samples from major tributaries to Prichard Creek exhibited metals concentrations below the EPA's primary and secondary Maximum Contaminant Levels (MCLs) and Idaho's acute and chronic aquatic life standards (IGS 1997). Samples collected from water flowing from two adits at the Orofino Mine did not exceed any primary or secondary drinking water MCLs for metals. However, the samples did exceed the chronic aquatic life standard for lead and the acute and chronic aquatic life standards for zinc (IGS 1997).

During Maxim's investigation, two surface water samples were obtained from Bear Gulch Creek upstream and downstream of the Bear Top/Orofino Mill Site. The upstream flow on November 15, 2001 was 2.1 cubic feet per second (cfs) and the downstream flow was 1.6 cfs.

Water quality in Bear Gulch Creek is neutral in pH, slightly alkaline, and contains relatively few dissolved solids and low concentrations of common ions. Cadmium, iron, lead, and zinc were the only total metals detected in the two surface water samples, and the only dissolved metal above the respective practical quantitation limits (PQL) was zinc. Concentrations of these metals were all higher in the downstream sample, indicating mine wastes in the Bear Gulch Mine Complex are impacting water quality. Both total and dissolved zinc concentrations (0.21 and 0.06 milligrams per liter [mg/L], respectively) exceeded the acute and chronic aquatic life standards.

TABLE 2
Rock and Soil Background Data, Sediment Levels, and Aquatic Standards for Metals
Bear Gulch Mine Complex

Element	Background Data[1]		Sediment Probable Effects Level (mg/kg) [2]	Constituent Standards (mg/L) [3]	Acute Aquatic Life Standard (mg/L) [4]	Chronic Aquatic Life Standard (mg/L) [4]
	Rock (mg/kg)	Soil (mg/kg)				
Aluminum	--	--	--	0.2**	--	--
Antimony	1.1	1.1	--	0.006	--	--
Arsenic	--	--	17	0.05	0.36	0.19
Cadmium	0.5	0.5	3.5	0.005	0.00082*	0.00037*
Chromium	24	32	90	0.1	0.176*	0.057*
Copper	11	29	197	1.3	0.0046*	0.0035*
Iron	24,000	37,000	--	0.3**	--	--
Lead	23	45	91	0.015	0.014*	0.00054*
Manganese	360	1,377	--	0.05**	--	--
Mercury	0.04	0.13	0.486	0.002	0.002	0.000012
Nickel	11	24	--	--	0.438*	0.049*
Silver	0.3	0.6	--	0.1**	0.00032*	0.00012*
Zinc	41	115	315	5	0.035*	0.032*

Notes: 1 Data for the Wallace Formation of the Belt Supergroup (998 samples) reported in IGS (1997)
2 Probable Effects Level for Freshwater Sediment from NOAA Sediment Quality Guidelines (NOAA, 1999).
3 From IDAPA 58.01.11.200 (2000)
4 From IDAPA 16.01.02.250 (2000)
** Indicates secondary constituent
* Based on 25 mg/L hardness as CaCO3
mg/kg = milligrams per kilogram; mg/L = milligrams per liter; -- Not available

These analytical results indicate the Bear Gulch Mine Complex likely impacts water quality. Water quality impacts result principally from mine waste present at the Bear Top/Orofino Millsite. These wastes, including tailings, reworked tailings, mixed tailings and alluvium, and concentrate, are in direct contact with the creek along the streambanks, in the streambed, and on adjacent areas along a stream length of at least approximately 1,000 feet.

3.3 SEDIMENT IN BEAR GULCH

Maxim collected two sediment samples in 2001 at the two surface water stations located in Bear Gulch Creek (Maxim, 2003). Sediment samples were analyzed for total metals concentrations. Total metals in the sediment samples were relatively low, and, except for lead and zinc in the downstream sample (540 and 610 milligrams per kilogram [mg/kg], respectively), were less than three times background concentrations. Total lead and zinc in the downstream sample were the only metals to exceed the PELs for these metals (Table 2).

Total lead and zinc concentrations were considerably higher in the downstream sediment sample than the upstream sample, indicating that the Bear Top/Orofino Mill Site and possibly the other mines in the Bear Gulch Mine Complex negatively impact sediment quality in Bear Gulch Creek. Lead was the only

metal detected in the leachable fraction of the two sediment samples analyzed. Leachable lead was only detected in the downstream sediment sample (Maxim, 2003).

3.4 ADIT DISCHARGES

There were five adit discharges present at the mine sites during the 2001/2002 field investigations. Table 3 summarizes total metals water quality data for the five adits. Flow rates from the adits were limited, with the highest flow measured at the two Orofino Mine adits (4 gallons per minute each). Flows from the other three adits were all less than one gallon per minute. Adit discharge water quality was generally near neutral in pH and contained relatively low concentrations of common ions (Maxim, 2003).

The primary metals of concern in the adit discharges are cadmium, copper, lead, and zinc. Zinc concentrations were generally the highest of the metals detected in the discharges, with the highest total zinc concentration of 8.17 milligrams per liter (mg/L) being measured at the Orofino Mine. This concentration was generally 10 times higher than zinc concentrations measured at the other adit discharges. Generally, cadmium, lead, and zinc exceeded State of Idaho acute and chronic water quality criteria, although loading of these metals to Bear Gulch is expected to be minor if at all for the flow regime sampled during the site investigation. The adit at the upper Bear Top Mine did not exceed any aquatic standards, but did exceed the human health standard for antimony (0.006 mg/L).

TABLE 3
Total Metals Concentrations in Adit Discharge Samples
Bear Gulch Mine Complex

SITE	Adit	Total Concentration (milligrams/liter)						
		Antimony	Arsenic	Cadmium*	Copper*	Lead*	Mercury	Zinc*
Bear Top Mine	FS-(U)-BT-101(SW)	0.028	0.01	<0.001	<0.001	0.005	<0.0002	0.02
	FS-(M)-BT-102(SW)	<0.005	<0.001	0.0021	0.001	0.045	<0.0002	0.71
Orofino Mine	FS-(U)-OM-101(SW)	<0.005	<0.001	0.024	0.002	0.33	<0.0002	3.83
	FS-(L)-OM-102(SW)	<0.005	<0.001	0.049	0.005	0.76	<0.0002	8.17
Ione Mine	FS-(L)-IM-101(SW)	<0.005	<0.001	0.005	0.002	0.043	<0.0002	0.2
Idaho Acute Aquatic Criteria		**--**	**0.36**	**0.00082**	**0.0046**	**0.014**	**0.002**	**0.035**
Idaho Chronic Aquatic Criteria		**--**	**0.19**	**0.00037**	**0.0035**	**0.00054**	**0.000012**	**0.032**

Note: * Adjusted for hardness of 25 milligrams per liter; from IDAPA 16.01.02.250 (2000)
Shading indicates exceedance of a standard.

3.5 MINE WASTE CHARACTERISTICS

Results for samples collected during the 1996 IGS investigation indicated arsenic, cadmium, and lead concentrations far exceeded background levels in the Bear Top/Orofino tailings and in waste rock present at the Silver Scott Mine. These results indicated that human health and environmental risks might be present at the sites in the Bear Gulch Mine Complex. According to data collected by Maxim in

2001 and 2002, tailings and waste rock contain elevated concentrations of trace metals including arsenic, cadmium, chromium, copper, manganese, lead, and zinc.

3.5.1 TOTAL AND LEACHABLE METALS RESULTS

For Maxim's 2001/02 investigation, samples were collected primarily from the uppermost surface of the 16 mine waste dumps present at the five mine sites and represent concentrations of metals that present a direct contact or ingestion hazard. Average total metals concentrations are shown in Table 4.

TABLE 4
Metals Concentrations in Mine Waste
Bear Gulch Mine Complex

SITE	WASTE TYPE	Concentration (milligrams/kilogram)					
		Arsenic	Cadmium	Copper	Lead	Mercury	Zinc
Bear Top/Orofino Mill Site	Waste Rock(1)	9	37	92	5,567	0.4	9,695
Silver Scott Mine	Waste Rock(1)	13	25	68	6,486	0.2	2,609
Bear Top Mine	Waste Rock (1)	11	27	91	21,905	0.4	9,668
Ione Mine	Lower Waste Rk(1)	56	1	38	70	0.1	96
	Mid/Upper Waste(1)	15	42	59	24,873	0.6	13,929
Orofino Mine	Waste Rock(1)	18	30	550	39,762	0.7	19,740
Waste Rock – All Sites(1)		**17**	**28**	**160**	**18,999**	**0.5**	**9,866**
Bear Top/Orofino Exposed Tailings(1)		**12**	**91**	**463**	**48,253**	**1.1**	**25,133**
Maximum Concentration – All Sites(2)		**180(w)**	**188(t)**	**1,530(w)**	**116,000(t)**	**2.4(w)**	**61,500(w)**
Background(3)		**--**	**0.5**	**29**	**45**	**0.13**	**115**

Notes: (1) Mean concentration; number of samples varies
(2) (w) = waste rock; (t) = tailings
(3) From Table 2 for soil

Data shown in Table 4 generally indicate that cadmium, copper, lead, mercury, and zinc are elevated above background concentrations in some wastes and at some of the mine sites. Results for the lower waste rock dump at the Ione Mine are shown separately in Table 4 because concentrations of all metals in this dump were near background concentrations.

The one common contaminant of concern that was present at all the mine dumps characterized (except the lower Ione Mine workings) is total lead (Table 4). Concentrations of total lead in nearly all mine waste samples exceeded 1,100 mg/kg, well above background levels (Maxim, 2003). The maximum total lead concentration was 116,000 mg/kg in tailings (Table 4).

The majority of samples submitted for analysis as part of Maxim's 2001/02 site investigation exhibited near-neutral pH levels (Maxim, 2003). However, even though most metals are generally less mobile at a neutral pH, leachate tests conducted on mine wastes indicated that the metals present in the waste are

leachable (Maxim, 2003). The most common leachable metals are lead and zinc, although cadmium, copper, and mercury (in one sample) were detected in synthetic leachate. Most leachable metals (4 or more) were measured above State of Idaho chronic aquatic life standards in samples collected from the Bear Top/Orofino Mill Site and the upper workings of the Orofino Mine.

3.5.2 ESTIMATED VOLUME OF MINE WASTE MATERIAL

Table 5 summarizes volume estimates of mine waste present at the five mine sites that make up the Bear Gulch Mine Complex.

TABLE 5
Mine Waste Volume Estimates
Bear Gulch Mine Complex

SITE	WASTE AREA	VOLUME (cubic yards)	Surface Area (square feet)
Bear Top/Orofino Millsite	Mill Disturbance/Debris	1,362	16,715
	Exposed Tailings	611	3,512
	Former Concentrate Loading Area	122	2,204
	Reworked/Redeposited Waste	9,870	115,869
	SITE TOTAL	**11,965**	**138,300**
Silver Scott Mine	Lower Workings Waste Rock Dump	1,503	11,318
	Upper Workings Waste Rock Dump	203	1,691
	SITE TOTAL	**1,706**	**13,009**
Bear Top Mine	Lower Workings Waste Rock Dump	9,700	8,123
	Middle Workings Waste Rock Dump	2,643	5,129
	Upper Workings Waste Rock Dump	800	2,698
	SITE TOTAL	**13,143**	**15,950**
Ione Mine	Lower Workings Waste Rock Dump	2,228	9,092
	Middle Workings Waste Rock Dump	7,676	5,688
	Upper Workings Waste Rock Dump	1,368	3,438
	Above Upper Workings Waste Rock Dump	228	670
	SITE TOTAL	**11,500**	**18,888**
Orofino Mine	Lower Workings Waste Rock Dump	4,225	14,423
	Upper Workings Waste Rock Dump	703	3,695
	Related Upper Workings Waste Rock Dump	491	2,930
	SITE TOTAL	**5,419**	**21,048**
BEAR GULCH MINE COMPLEX TOTAL		**43,733**	**207,195**

Thickness of tailings present at the Bear Top/Orofino Mill Site was measured in test pits, and the extent of these mine waste materials was identified in the field and surveyed. An average thickness was calculated based on test pit measurements and the volume calculated using the average thickness multiplied by the area. Waste rock thickness at the other dump sites was based on field estimates from visual observations of the variation from an approximated natural slope. Waste rock volume estimates were established primarily on field observation of the dump surface topography, surrounding native surface topography, and estimates of dump thickness. These volume estimates are approximations and should be considered qualitative. Where possible, a surface model of the dump and surrounding topography were contoured with Surfer® to generate a waste thickness model and calculate volume.

The greatest volume of mine waste present at the five sites was found at the Bear Top/Orofino Mill Site and the Bear Top Mine (about 12,000 and about 13,000 cubic yards, respectively). The Silver Scott Mine had the lowest volume (about 1,400 cubic yards). The total volume of mine waste at the five sites is about 44,000 cubic yards.

3.6 SOURCE-PATHWAY-RECEPTOR CONCEPTUAL MODEL

Site investigation data collected in 1996 (IGS 1997) and 2001-2002 (Maxim, 2003) provide an understanding of the primary source, pathways, and potential receptors of mining-related contaminants from the Bear Gulch Mine Complex. This understanding is the basis for a conceptual model of contaminant characteristics that will be used to develop RAOs and reclamation alternatives directed to mitigate these characteristics. Principal contaminants associated with the waste rock and tailings are, cadmium, copper, lead, and zinc.

The primary sources of contaminants are waste rock dumps located on the hillsides above Bear Gulch and mill concentrate, tailings, and mixed tailings located at the former Bear Top/Orofino Mill Site. Contaminants are released from waste rock and tailings into the environment by several mechanisms. Precipitation infiltrates mine wastes and leaches contaminants into underlying soil and groundwater. Tailings may be saturated in Bear Gulch Creek during high flow conditions, placing the tailings in direct contact with groundwater. Bear Gulch Creek bisects the tailings, eroding them into the stream, and these materials are subsequently incorporated into streambed sediments. During those periods when surface water is in contact with the tailings, dissolution of contaminants into surface water, and erosion of tailings into the stream causes offsite movement of contaminants. Waste rock present on the steep slopes above the stream is vulnerable to erosion during high precipitation and runoff events, and downslope movement of waste rock is actively occurring.

Exposure pathways to humans and animals appear to be primarily related to direct contact or ingestion of contaminants. Current risks to humans on National Forest System lands are limited to recreationists. Private owners hold patents to four of the mines and the mill site. Although the site is relatively remote and vehicle access is currently problematic, the site is unsecured and available to users of National Forest System land.

Ecological receptors of contaminants may include aquatic organisms living in Bear Gulch and animals drinking from the stream. Several metals in surface water and streambed sediments increase in concentration directly downstream of the site relative to upstream of the site. Ecological exposure could be via direct contact with, or ingestion of, contaminants.

4.0 RISK EVALUATION

A streamlined risk evaluation process was used to assess threats to human health and the environment associated with exposure to mine waste at the five mine sites in the Bear Gulch Mine Complex. Risks are evaluated using site-specific chemical concentration data, applicable exposure scenarios, and pertinent cleanup guidelines or ecological criteria. This streamlined risk evaluation examines risks under existing conditions, assuming no cleanup activities are performed at the site.

The streamlined risk evaluation method used in this section relies almost exclusively on the outcome of a human health risk assessment (HHRA) and an ecological risk assessment (EcoRA) that were prepared by the Idaho Department of Health and Welfare (IDHW) and the EPA, respectively, for the Bunker Hill Mining and Metallurgical Complex (IDHW, 2001; EPA, 2001), a site listed by the EPA on the National Priority List (NPL) in 1983. Tributaries of the North Fork of the Coeur d'Alene River are included in the broader area of the NPL Site, which encompasses the entire Coeur d'Alene Basin (Basin) from the headwaters of the Coeur d'Alene River to the Spokane River. Although no site specific studies of risk were performed specifically for the Bear Gulch Mine Complex for the HHRA and the EcoRA, the types and levels of contamination present in Bear Gulch are similar to those present in the Basin.

The Bunker Hill Site is located primarily in Shoshone and Kootenai counties in the Idaho panhandle and is divided into three operable units (OUs). Operable Unit 1 includes the populated areas of the Bunker Hill Box, a 21 square mile area that includes the former Bunker Hill smelter and the town of Kellogg. Operable Unit 2 includes the non-populated areas of the Box. Operable Unit 3 includes mining-related contamination in the broader Coeur d'Alene Basin (EPA, 2002). During the late 1990s, beginning in 1997, EPA collected more than 10,000 environmental samples including soil, sediment, groundwater, surface water, and other environmental media in the Basin (EPA, 2002). These samples, combined with 7,000 samples collected by various other agencies involved in the cleanup of the Site, provided a solid basis to support risk management decisions for the Basin.

4.1 STREAMLINED HUMAN HEALTH RISK EVALUATION

The first comprehensive study of human health effects outside of the Bunker Hill Box was conducted in 1996 by the IDHW and the Agency for Toxic Substances and Disease Registry (ATSDR). The study found excessive levels of lead absorption in children that was associated with lead loading in dust mats and bare soil in outdoor play areas (IDHW, 2000). The human health risk assessment for the Basin involved four steps: (1) selection of chemicals of potential concern (COPCs), (2) completion of an exposure assessment, (3) performance of a toxicity assessment, and (4) completion of risk characterization.

Lead and non-lead metals were analyzed differently in the HHRA. The lead analysis is based on predicting blood lead levels using central tendency exposure values. The blood lead risk integrates exposure, toxicity, and risk. For the other metals, risk is described in terms of an external dose. Health risks for chemicals that cause cancer are calculated differently than those for chemicals that cause non-cancer effects. For non-cancer risks, a person exposed to a chemical dose equal to or less than the "threshold" no adverse effects are expected. The hazard quotient for a chemical is the exposure dose from the site divided by the reference dose of the chemical. If the hazard quotient is below or near 1.0, than no adverse effects are anticipated.

Cancer risks are calculated assuming that carcinogens at any non-zero dose, contribute to cancer risk. Cancer risks are presented as the incremental increased risk in the likelihood of developing cancer. EPA

uses the general excess order of magnitude risk range of one excess cancer risk in one million ($1x10^{-6}$) to one excess cancer risk in 10,000 ($1x10^{-4}$) as a target range within which risks are managed.

4.1.1 CONTAMINANTS OF POTENTIAL CONCERN IN BEAR GULCH

The COPCs for protection of human health in the Basin are:

- Antimony, arsenic, cadmium, iron, lead, manganese, and zinc in soil and house dust
- Antimony, arsenic, cadmium, lead, and zinc in groundwater
- Arsenic, cadmium, lead, manganese, and mercury in surface water
- Lead and arsenic in tap water
- For fish consumption, the COPCs are cadmium, lead, and mercury

Tables 6 and 7 summarize concentrations of COPCs present in the Bear Gulch Mine Complex compared to background (for mine waste) and standards (for surface water). Standard EPA criteria that must be collectively satisfied to establish a COPC are that a contaminant: (1) is associated with mining wastes present at the site; (2) has an average concentration at least three times average background levels; and (3) has been measured at concentrations above the detection limit in at least 20% of the samples analyzed.

TABLE 6
Concentrations Of COPCs In Mine Waste
Bear Gulch Mine Complex

Contaminant	Average Tailings Concentration (mg/kg)[1]	Average Waste Rock Concentration (mg/kg)[1]	Soil Background Concentration (mg/kg)[1]	Average divided by Background[2]
Arsenic	12	17	22	0.77/0.54
Cadmium	91	28	0.5	182/56
Copper	463	160	29	16/5.5
Lead	48,253	18,999	45	>1,000/422
Mercury	1.1	0.5	0.13	8.5/3.8
Zinc	25,133	9,866	115	218/86

Notes: (1) Data from Table 4 in milligrams per kilogram (mg/kg)
(2) First number is for tailings, second number is for waste rock; numbers higher than 3.0 indicate chemical of potential concern (COPC)

TABLE 7
Concentrations Of COPCs In Surface Water
Bear Gulch Mine Complex

Contaminant of Concern	Surface Water Concentration (milligrams/liter) (1)	Constituent Standard (milligrams/liter) (2)	Concentration divided by Standard(3)
Antimony	0.028	0.006	4.6
Arsenic	0.01	0.01	1
Cadmium	0.049	0.005	9.8
Lead	0.76	0.015	51
Zinc	8.17	5	1.6

Notes: (1) Highest total concentration measured in five adit discharge samples in 2002 (Maxim, 2003); no contaminant exceeded the primary or secondary constituent standards in Bear Gulch Creek.
(2) From Table 2
(3) Numbers higher than 1.0 indicate chemical of potential concern (COPC)

Based on the above referenced criteria, cadmium, copper, lead, mercury, and zinc are COPCs for mine waste (Table 6). For surface water risk, COPCs were identified if total metals concentrations in adit discharges or in the downstream Bear Gulch Creek sample exceeded the total concentration in the Bear Gulch Creek upstream sample by three times, and exceeded MCLs established by the EPA for drinking water. Based on data from Maxim's site investigation report (Maxim, 2003), concentrations of aluminum, arsenic, chromium, copper, iron, manganese, mercury, nickel, and silver are not greater than three times background, were not detected in more than 20% of the samples, or do not exceed the respective water quality standard. Concentrations of antimony, cadmium, lead, and zinc exceed the primary or secondary constituent water quality standards and are therefore considered COPCs for surface water. For sediment, only lead and zinc exceeded three times background (Section 3.3).

4.1.2 EXPOSURE ASSESSMENT

For human health, the primary media of concern for the Basin are reported by the EPA (2002) to be the following:

- Contaminated soil where it occurs in residential areas, commercial areas, common use areas, and airborne dust generated at these locations
- Contaminated house dust
- Drinking water from wells or surface water
- Contaminated fish
- Contaminated homegrown vegetables
- Contaminated floodplain soil, sediments, and vegetation.

People in the Basin can be exposed to COPCs by ingesting soil, breathing dust, drinking water, and eating contaminated fish or homegrown vegetables. Current human exposure to site-related contaminants in soil and surface water is assumed to be via seasonal recreational activities within the Bear Gulch drainage on National Forest System lands. There is currently no residential use of the site, although portions of several waste rock dumps and the mill site are located on patented claims.

Of the four exposure scenarios analyzed in the HHRA, the public recreational exposure scenario is the closest to the current land-use scenario that exists in the Bear Gulch drainage. The public recreational

scenario was evaluated for children and adults who use developed parks and playgrounds, and undeveloped recreational areas, whether they are residents or visitors. Exposure scenarios included the incidental ingestion of soils, sediments, and surface water, and the ingestion of fish by sport fisherman. The public recreational scenario exposure assessment analyzed by the EPA for the Basin is considered comparable and applicable to current exposure in the Bear Gulch Mine Complex.

A residential scenario for the patented claims containing mine waste has not been developed for this EE/CA, and it is important to note that the streamlined risk evaluation process is not intended to predict potential future risks resulting from a land use change. Only a detailed risk assessment can accurately determine the risks involved with residential use at sites in the Bear Gulch Mine Complex. No assumptions are made for groundwater, as water quality of groundwater beneath the site is not known and there are no existing wells drawing water at the site.

4.1.3 RISK CHARACTERIZATION

Of the eight metals selected as chemicals of potential concern and evaluated in-depth in the HHRA, two metals, lead and arsenic, were identified as chemicals of concern (COCs) because lead exposures are predicted to exceed target health goals at the largest number of locations and arsenic concentrations exceeded target health goals. Other metals exceeding health goals were either limited to isolated locations or co-located with lead and arsenic, and therefore not a primary concern.

For the public recreational scenario, no cancer or non-cancer risk from non-lead metals is present in the Basin, and this appears to apply to Bear Gulch as well. The only carcinogen present at the Complex is arsenic, and arsenic does not exceed background in mine waste or sediment and does not exceed the surface water standards in Bear Gulch Creek or in the adit discharges. The only cancer risk estimates for residential exposures in the Basin on a whole were found in only two discreet areas of the Basin the were equal to or exceeded $1x10^{-4}$.

Therefore, for human health risk, the COC in the Bear Gulch Mine Complex is lead and the exposure is through ingestion. The other COPCs in soil and sediment, cadmium, copper, mercury, and zinc, are co-located with lead and, as in the Basin as a whole, are not addressed separately. Human exposure to dust is not considered to be significant in the Complex due to the coarse nature of the mine waste materials.

There is no human health risk to COPCs in surface water or groundwater, since humans do not currently ingest surface water from the adit discharges, and there are currently no users of groundwater. Risk in the Basin from fish consumption was limited to subsistence living scenarios, and consumption of fish caught in the vicinity of the Bear Gulch Mine Complex by recreationists is likely limited, although there are no site specific data quantifying this risk.

4.2 STREAMLINED ECOLOGICAL RISK EVALUATION

The EcoRA for the Coeur d'Alene Basin (EPA, 2001) was prepared to characterize risks for aquatic and terrestrial organisms. The portions of the Basin EcoRA that pertain to the Complex are described in the EcoRA for conceptual site model (CSM) Unit 1. There are five CSM units in the Basin that were differentiated based on geomorphology, types of contaminants, and habitats. The CSM Unit 1 contains many of the primary sources for mining-related hazardous substances including mining wastes in Prichard Creek.

The habitats present in CSM Unit 1 applicable to the Complex are riverine and upland. The riverine habitat includes wetlands and deepwater habitats within the Bear Gulch channel. Typical fish expected to occur include westslope cutthroat trout, bull trout, sculpin, mountain whitefish, and, in some portions of the Basin, rainbow, brook, and brown trout. The upland habitat includes forested areas with mule deer, mouse, vole, shrew, great horned owl, wild turkey, ruffed grouse, American kestrel, and Swainson's thrush as representative of mammals and birds.

The streamlined ecological risk evaluation was completed to assess the potential risk that mine wastes at the site pose to plants and animals. The evaluation was performed by comparing concentrations of contaminants of ecological concern (COECs) in surface water, sediment, and soil at the site with the results of the EPA EcoRA for the Basin. Although there are no site-specific ecological risk data available for the Bear Gulch Mine Complex, the ecological risk evaluation is supported in a larger way by the work completed by the EPA (EPA, 2001).

As this streamlined ecological risk evaluation focuses on COECs, no evaluation is done with respect to the physical habitat present at the site or in Bear Gulch Creek, nor is an assessment made toward how other factors may have affected aquatic or terrestrial populations. Although, the EPA's EcoRA did take into account habitat factors in determining concentrations of contaminants that were considered protective of ecologic receptors, the presence or absence of appropriate habitat for animals, spawning reeds for fish, or the health of wetlands and riparian areas, while it may affect the presence, diversity, or nature of aquatic and terrestrial populations, are not considered under this streamlined risk evaluation. The ecological risk of the COECs in vegetation to grazing animals, including wildlife, is not evaluated because no site-specific data have been collected to determine grazing habits or duration of exposure to animals frequenting the site. However, this pathway of exposure is likely minimal because the Complex is small relative to the area within the vicinity of the Complex that could be used for forage, and forage growing on waste rock or tailings is unlikely to be a key food source for many, if any, species.

The ecological risk evaluation, like the human health risk evaluation, estimates the current risk presented at the site and involves: 1) identifying COECs; 2) exposure assessment; 3) ecological effects assessment; and 4) risk characterization. This risk evaluation summarizes the results of the EPA's EcoRA, evaluates available site data with respect to the benchmarks developed by the EPA, and then characterizes overall risk by integrating EPA's results with site investigation data.

4.2.1 CONTAMINANTS OF ECOLOGICAL CONCERN

Contaminated media that potentially affect ecological receptors in the Basin are surface water, soil, and sediment. The COECs identified by the EPA for ecological protection are:

- Cadmium, copper, lead, and zinc in surface water
- Arsenic, cadmium, copper, lead, and zinc in soil
- Arsenic, cadmium, copper, lead, mercury, silver and zinc in sediment

Table 8 lists concentrations of COECs in Bear Gulch Creek surface water and sediment, and average concentrations of COECs in exposed tailings located at the Bear Top/Orofino Millsite. These concentrations are compared to applicable standards. In Bear Gulch Creek, COECs were identified if dissolved metals concentrations in the downstream Bear Gulch Creek sample exceeded the most restrictive water quality standard, the chronic aquatic standard for metallic contaminants. For sediment and soil, the Basin EcoRA identified concentrations of COECs protective of aquatic organisms and terrestrial biota.

TABLE 8
Comparison Of Bear Gulch Concentrations To Standards
Bear Gulch Mine Complex

Contaminant	Chronic ALS[(1)] (mg/L)	Bear Gulch Creek[(2)] (mg/L)	Sediment Standard[(3)] (mg/kg)	Bear Gulch Sediment[(4)] (mg/kg)	Soil Standard[(5)] (mg/kg)	Average Tailings[(6)] (mg/kg)
Arsenic	0.19	<0.001	22	3	67	12
Cadmium	0.00037	<0.0001	2.7	3	105	91
Copper	0.0035	<0.001	53	26	751	463
Lead	0.00054	<0.003	171	540	159	48,253
Mercury	0.000012	<0.0002	0.3	<0.02	--	1.1
Zinc	0.032	0.06	280	610	434	25,133

Notes: (1) Chronic aquatic life standards, Idaho Administrative Procedures Act; chronic standard adjusted for total hardness of 25 mg/L.
(2) Dissolved concentration in downstream station FS-MS-101(SW)
(3) Concentration for sediment protective of aquatic organisms (EPA, 2002)
(4) Total concentration in downstream station FS-MS-101(SE)
(5) Concentration for soil protective for terrestrial wildlife (birds and mammals occurring in upland, agricultural and riparian habitats); concentration Is lowest observed adverse effect level for population (EPA, 2002)
(6) Bear Top/Orofino Millsite tailings average
-- Criteria not currently available
mg/L = milligrams per liter; mg/kg= milligrams per kilogram
Shading indicates exceedance of applicable standard

Based on shaded cells in Table 8 that show exceedances of the applicable standard, zinc is the only constituent to exceed the chronic water quality standards in Bear Gulch Creek. For sediment, cadmium, lead, and zinc exceed the concentrations protective of aquatic organisms. In soil, concentrations of lead and zinc exceed the applicable standard for wildlife populations.

4.2.2 EXPOSURE ASSESSMENT

Many studies have been conducted in the Basin to characterize exposures of plants and animals to mining-related hazardous substances. The potential routes of exposure by which ecological receptors may be exposed to COECs in the Basin include the following:

- Birds and mammals – ingestion of soil or sediment, surface water, and food
- Fish – ingestion and direct contact with sediment and surface water
- Benthic invertebrates – ingestion and direct contact with sediment or surface water
- Aquatic plants – root uptake and direct contact with sediment and surface water
- Amphibians – direct contact with surface water and soil or sediment
- Terrestrial plants – root uptake from soil or sediment
- Terrestrial invertebrates – ingestion and direct contact with soil or sediment
- Soil processes – direct contact of microbes with soil or sediment

Because wildlife are mobile and their exposure is best represented by the average concentration within areas they inhabit, the 95% upper confidence limit (UCL 95) is the measure traditionally used for estimation of exposure for wildlife.

Potentially adverse exposures of fisheries, aquatic life, and terrestrial plants and animals can be semi-quantitatively assessed by comparing site-specific surface water, sediment, and soil data to toxicity-based criteria and standards for the respective media. Exposure pathways for fisheries and aquatic life include: 1) direct exposure of fish and aquatic organisms (e.g. insect larvae, fish embryos) to metals in surface water that exceed toxicity thresholds; 2) exposure of fish and aquatic organisms to sediment pore water that is toxic due to contaminants in the sediments; and 3) ingestion of aquatic species (e.g. insects) that have bio-accumulated contaminants to the extent that they are toxic to predators (e.g. fish). Native terrestrial plants could be exposed to phytotoxic effects related to elevated concentrations of metals in soil or mine wastes at the site. Animals could be exposed to direct ingestion of soil and/or elevated concentrations of metals in plants growing in waste rock and tailings present at the site, although waste rock and tailings cover only a very small percentage of the contaminated area, and this pathway of exposure is unlikely.

4.2.3 ECOLOGICAL EFFECTS ASSESSMENT

Two kinds of measures were evaluated for ecological effects – measures of effects, and measures of ecosystem and receptor characteristics. The end product of the ecological effects characterization is a range of toxicity reference values (TRVs) that was combined with exposure estimates or exposure point concentrations to estimate potential risks in the risk characterization. Measures of ecosystem and receptor characteristics were also evaluated for their potential effects on identified receptors, including habitat for special-status or other species.

The ecological effects characterization consists of an evaluation of available toxicity or other effects information that can be used to relate exposure estimates to a level of adverse effects. Three categories of effects data were available for the assessment of ecological risks in the Coeur d'Alene Basin: 1) Literature-derived or site-specific single-chemical toxicity data; 2) Site-specific ambient media toxicity tests; and, 3) Site-specific field surveys.

4.2.4 RISK CHARACTERIZATION

The Basin EcoRA integrated the ecological exposure and ecological effects assessments to provide a screening level estimate of potential adverse ecological impacts to aquatic life and native terrestrial plants. This was accomplished by calculating hazard quotients (HQs). Determination of risk to receptors was performed by weight-of-evidence evaluation. Based on the potential risks of adverse effects to those ecological receptors, the EcoRA identifies the final chemicals of ecological concern (COECs). Concentrations of COECs in environmental media were identified that preserve the desired attributes of the assessment endpoints, and below which adverse effects are expected either to be absent or to be within defined limits of effects levels. These concentrations were often determined by levels of contaminants that would be protective of the most sensitive ecological receptor that is exposed to a particular medium.

The results of the EcoRA indicate that most watersheds in which mining has occurred and a large portion of the Basin downgradient of mining areas are ecologically degraded as a direct or secondary effect of mining related hazardous substances. The general conclusion is that the greatest risk to birds is from lead and zinc; no single COEC stands out as a predominant risk driver for mammals. Zinc, lead, and arsenic were the most common risk drivers.

4.2.4.1 Surface Water - Aquatic Life

For fish and other aquatic organisms, based on comparison of metals concentrations to chronic and acute aquatic water quality criteria, surface water in Bear Gulch Creek may be lethal to some aquatic life due to zinc concentrations measured above the chronic standard. For amphibians, the Basin EcoRA did not identify any risks in the Prichard Creek drainage, which includes Bear Gulch.

4.2.4.2 Sediment - Aquatic Life

Toxic effects of contaminated sediment were identified in the Basin EcoRA to contribute to adverse effects on aquatic life in Prichard Creek tributaries, including Bear Gulch. Toxic effects to aquatic life from sediments are identified for lead and zinc.

4.2.4.3 Terrestrial Biota

For plants and soil microbes, exposure to lead and zinc may present significant risks to populations of selected plant receptors. This may be the case in Bear Gulch, where the unvegetated condition of waste rock dumps may be a result of excessive metals concentrations. Based on chemical concentrations in waste rock and tailings, lead and zinc are the likely metals that pose a risk to terrestrial biota.

5.0 REMOVAL ACTION SCOPE AND OBJECTIVES

The evaluation of risk for the site (Section 4.0) demonstrated that the Bear Gulch Mine Complex presents both human health and ecological risks from metals in mine waste. For human health risk, lead is the only COC that exhibits concentrations that could cause elevated levels of lead in the blood of adults and children. The human health risk primarily results from exposure to lead through ingestion; dust inhalation does not appear to be a problem, as the mine wastes in the Complex are predominantly coarse grained. For ecological risks, zinc is present in surface water at concentrations that exceed chronic aquatic water quality criteria, cadmium, lead, and zinc are present in sediment in concentrations that could pose a risk to aquatic organisms, and lead and zinc are present in soil at concentrations that could impact terrestrial biota.

Under the non-time-critical removal action process, if the lead agency determines there is a threat to public health, welfare, or the environment, a removal action may be taken to abate, prevent, minimize, stabilize, mitigate, or eliminate the release or threat of release of a hazardous substance. This section of the EE/CA presents the scope of the removal action, preliminary removal action objectives (RAOs), and project goals.

5.1 SCOPE OF THE REMOVAL ACTION

Proposed removal actions are required to meet specified cleanup levels while working within statutory limits and attaining applicable or relevant and appropriate requirements (ARARs) to the extent practicable. Removal actions must also consider the potential for future removal actions that may be undertaken at the site, and must not preclude these actions even if not currently planned. The removal action considered for the Bear Gulch Mine Complex is an initial response to the release of hazardous substances at the site. While this removal action may not be the sole response taken at the site, there are currently no other removal actions planned.

The scope of a removal action considered in this EE/CA is limited to reducing or eliminating uncontrolled releases of metals from mine tailings and waste rock present within the Bear Gulch Mine Complex. Addressing environmental impacts associated with mill tailings and waste rock, regardless of whether the wastes are removed or controlled in-situ, will mitigate the movement of metals from the site into the surrounding environment, disrupting the direct release pathway that allows metals to migrate into site soil and water unchecked. A removal action that addresses mill tailings and waste rock present within the Complex presumes that some attendant reduction in contaminant concentrations will occur in surface water, groundwater, and stream sediment as a result of removing or controlling the primary source of contamination.

The scope of this initial removal action does not include control or treatment of mine discharges and does not directly address contamination of groundwater resources that may be impacted by mine discharges. While these problems may be addressed in future removal actions at the site, monitoring the effectiveness of the initial removal action will be the primary basis to determine if any future removal actions are necessary.

5.2 PRELIMINARY REMOVAL ACTION OBJECTIVES

Preliminary removal action objectives (PRAOs) for the project are:

- Reduce or eliminate safety hazards
- Reduce or eliminate human health hazards associated with metals contamination
- Reduce or eliminate hazards presented by sediment and metals contamination to the stream in Bear Gulch
- Improve aquatic health and habitat

5.3 ARAR-BASED GOALS

A preliminary list of ARARs that apply to proposed removal action activities is presented in Appendix A. This list of ARARs includes Federal or State environmental laws, regulations, or facility siting laws, that govern activities that would be pertinent to any cleanup actions considered at the Bear Gulch Mine Complex. The NCP requires that ARARs be met to the extent practical, considering the urgency of the situation. An analysis of ARARs is completed for each alternative considered in the EE/CA to determine if the alternative complies with the substantive sections of environmental laws and regulations, so that due consideration is given as to whether cleanup activities may cause further problems than present under existing conditions. In many cases, ARARs may form the basis for removal action objectives selected for a project, such as reducing concentrations of contaminants of concern in receiving waters to below statutory limits set by the Clean Water Act.

Compliance with the substantive portions of state and federal regulations are an overall goal for the project. However, overall goals are not meant to apply to any one removal action at the site. Meeting the substantive portions of identified ARARs is generally accomplished by insuring project activities follow best available technologies. Numeric goals are primarily contaminant-based concentrations that are set by federal or state laws and regulations. For this project, the primary contaminant-specific ARARs apply to surface water. There are no contaminant-specific ARARs for soil media.

Aquatic life standards and human health standards are common ARARs for surface water. Generally, the more stringent of the two standards is identified as the ARAR-based goal. As the aquatic life standards are more stringent than the human health standards for the COCs, aquatic standards are the surface water goals. These goals are presented in Table 9. Surface water criteria that are hardness dependent have been calculated based on a hardness of 25 mg/L, which is the hardness measured in 2002 in Bear Gulch. Although cleanup actions need not immediately achieve surface water quality standards, the most restrictive standards are the ultimate cleanup goal. Based on 2001 water quality data in Bear Gulch Creek, only dissolved zinc currently exceeds the goals for surface water.

No goals have been set for groundwater since it is unknown at this time whether groundwater is impacted. By limiting the scope of the removal action to treatment or removal of mine waste, groundwater quality may be positively affected, but no direct action related to groundwater is contemplated for this removal action.

TABLE 9
ARAR-Based Removal action Goals For Surface Water
Bear Gulch Mine Complex

	Dissolved Metals (milligrams/liter)			
	Cadmium	**Copper**	**Lead**	**Zinc**
Goal	0.00037	0.0035	0.00054	0.032

Note: Goals are adjusted for a hardness of 25 milligrams/liter

5.4 RISK BASED GOALS

The results of the streamlined risk evaluation indicate that cadmium, lead, and zinc in mill tailings and waste rock present human health and environmental risks at the site. The HHRA and EcoRA prepared for the Basin lists concentrations of COCs that are protective to human health and the environment. These concentrations are listed in Table 10.

TABLE 10
Risk-Based Guidelines For Sediment And Soil
Bear Gulch Mine Complex

	Total Metals (milligrams/kilogram)		
	Cadmium	**Lead**	**Zinc**
Human Health Guideline[(1)]	--	1,000	--
Sediment Guideline[(2)]	2.7	171	280
Soil Guideline[(3)]	105	159	434

Notes: (1) Guideline from EPA (2002) for public recreational activities
(2) Concentration for sediment protective of aquatic organisms (EPA, 2002)
(3) Concentration for soil protective for terrestrial wildlife (birds and mammals occurring in upland, agricultural and riparian habitats); concentration Is lowest observed adverse effect level for population (EPA, 2002)
-- not applicable

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6.0 SCREENING AND DEVELOPMENT OF REMOVAL ALTERNATIVES

The conceptual model that portrays contaminant sources, release mechanisms, and exposure pathways (Section 3.6) and the PRAOs developed for this project (Section 5.0) provide the basis for screening and development of removal alternatives for the tailings and waste rock within the Complex. The process presented in this section follows EPA guidance for non-time-critical removal actions (EPA, 1993) by first identifying potential response technologies and process options, screening these options through consideration of practical applications of the technologies to the scope of the removal action, and then assembling the remaining technologies and options into removal action alternatives. Alternatives are evaluated in detail against three primary criteria in Section 7.0.

6.1 RESPONSE TECHNOLOGY AND PROCESS OPTION SCREENING

Because the scope of this removal action is limited to control or elimination of hazardous substances from mill tailings and waste rock, potential response technologies and process options are limited to those that apply to source control. No evaluation was conducted for technologies that directly address adit discharges, surface water, or groundwater, although these environmental media may be addressed in future removal actions. However, addressing environmental impacts associated with mill tailings and waste rock presumes that some reduction in contaminant concentrations will occur in surface water and groundwater as a result of removing or controlling the primary sources (tailings and waste rock) of metals contamination.

The purpose of identifying and screening technology types and process options is to eliminate those technologies that are likely unfeasible for this site, while retaining potentially effective options. General response actions potentially capable of achieving RAOs and goals at the waste locations are screened for applicability in Table 11. Response actions include no action, institutional controls, engineering controls, excavation and treatment, and in-situ treatment. The general response actions, technology types, and process options are discussed in the text following the table. Screening comments are found in Table 11, and the logic and reasons for screening out technologies or process options are discussed in the text. Technologies and options retained for alternative development are shaded in Table 11. Descriptions of the five general response actions are presented below.

6.1.1 NO ACTION

No action involves no further response or monitoring. No action serves as a baseline against which other response options are compared and is therefore ***retained*** as an alternative.

6.1.2 INSTITUTIONAL CONTROLS

Institutional controls are used to restrict or control access to or use of a site. Land use and access restrictions are potentially applicable institutional controls. Land use restrictions would limit possible future uses of the land through IPNF's forest management plan.

TABLE 11
Response Technology Screening Summary
Bear Gulch Mine Complex

General Response Action	Response Technology	Process Option	Description	Screening Comment
NO ACTION	None	Not Applicable	No Action	Retained for comparison to other options.
INSTITUTIONAL CONTROLS	Access Restrictions	Road and Trail Closures	Install closure gates or earthen berms to limit vehicular access to contaminated areas.	Potentially effective in conjunction with other technologies; not effective in preventing wildlife access; readily implementable; requires long-term maintenance.
		Fencing	Install fences around contaminated areas to limit access.	Potentially effective in conjunction with other technologies; not effective in preventing wildlife access; readily implementable; requires long-term maintenance; more expensive than road closures.
		Land Use Controls	Legal restrictions to control current and future land use.	Potentially effective in conjunction with other technologies; readily implementable;
ENGINEERING CONTROLS	Containment	Soil Cover	Native soil used to cover waste; soil vegetated; covers contaminant source to prevent direct contact.	Reduces surface infiltration by evapotranspiration; not effective in early spring or late fall when plants are dormant; not readily implementable on waste rock dumps due to steep slopes and inaccessible terrain to waste rock dumps; potentially effective for tailings if tailings are removed from the floodplain.
		Multi-layered RCRA Cap	Compacted clay layer covered with soil and vegetation in contaminated surface areas.	Effective in isolating wastes from infiltration;; readily implementable; not cost effective for small sites. Not retained due to the availability of disposal in an on-site repository.
		Asphalt or Concrete Cover	Apply asphalt or concrete over areas of exposed ore/waste rock.	Limited feasibility due to cracking over the long term; long-term maintenance required.

Note: Shading indicates technology or process option retained for further consideration.

TABLE 11 (Continued)
Response Technology Screening Summary
Bear Gulch Mine Complex

General Response Action	Response Technology	Process Option	Description	Screening Comment
ENGINEERING CONTROLS (continued)	Surface Controls	Consolidation	Consolidate mine waste into single area.	Effective way to reduce risk to direct contact; readily implementable for tailings and accessible waste rock dumps.
		Reshaping/ Recontouring	Modify waste rock dump surfaces to reduce slopes for managing runoff, erosion and surface infiltration.	Potentially reduces contaminant mobility by minimizing erosion; readily implementable; not retained for waste rock dumps due to steep slopes; not retained for tailings due to floodplain location.
		Revegetation	Revegetate by means of seed and mulch and/or trees and shrubs to stabilize steep slopes. Reduces infiltration by increasing water use (evapotranspiration); helps to stabilize and control erosion.	Effective in stabilizing wastes which do not contain phytotoxic contaminant concentrations; readily implementable.
		Erosion Protection/Run-on Control	Erosion resistant materials and/or commercial fabrics placed over mine wastes; stormwater diversion structures constructed to channel water away from mine wastes.	Potentially effective at reducing lateral contaminant migration; does not reduce contaminant mobility; potentially effective if combined with other process options; readily implementable.
	On-site Disposal	Soil Cap	Excavate mine waste and dispose in on-site repository with soil cap.	Potentially effective; readily implementable; not retained as this option conflicts with the design of Cell 1 at the USDS-FS repository.
		Composite Cover	Excavate mine waste and dispose in on-site repository with composite cover; liner included in cover system design.	Potentially effective; readily implementable; retained due to the availability of on-site disposal and the design of Cell 1 at the USDS-FS repository.
		Composite Cover with Leachate Collection System	Excavate mine waste and dispose in on-site repository with composite cover and leachate collection system; liners included in both cover system and at base of repository.	Potentially effective; readily implementable; not retained as this option conflicts with the design of Cell 1 at the USDS-FS repository.

Note: Shading indicates technology or process option retained for further consideration.

TABLE 11 (Continued)
Response Technology Screening Summary
Bear Gulch Mine Complex

General Response Action	Response Technology	Process Option	Description	Screening Comment
ENGINEERING CONTROLS (continued)	On-site Disposal (continued)	RCRA Designed Containment Facility	Excavate mine waste and dispose in on-site repository.	Potentially effective; higher costs associated with cover system and liner installations; implementable. Not retained because this option conflicts with the design of Cell 1 at the USDS-FS repository.
	Off-site Disposal	RCRA Landfill	Excavate mine waste and dispose in RCRA-C permitted facility.	Potentially effective because contaminant sources would be removed; high costs associated with transportation, and tipping fees; implementable. Not retained because on on-site repository location is available.
		Solid Waste Landfill	Excavate mine waste and dispose in non-hazardous solid waste facility.	Potentially effective for non-hazardous materials or residue from other treatment options; readily implementable; cost very high due to long haul distances and tipping fees. An administrative policy by the USDA does not allow disposal of mining wastes at a solid waste facility.

TABLE 11 (Continued)
Response Technology Screening Summary
Bear Gulch Mine Complex

General Response Action	Response Technology	Process Option	Description	Screening Comment
EXCAVATION & TREATMENT	Reprocessing	Milling and Smelting	Excavate and haul mine waste to operating mill and/or smelter for extraction of precious and non-precious metals.	Potentially effective if economic concentrations of metals are present; not readily implementable due to small volume of waste and lack of nearby processing facility; high cost.
	Fixation/ Stabilization	Cement/ Pozzolan Additive	Solidify mine waste with non-leachable cement or pozzolan.	Extensive treatability testing and proper disposal of stabilized material would be required. Potentially implementable but cost prohibitive.
		Lime Fixation	Mine waste treated with lime amendments to reduce mobility of metals.	Lime treatment effective for acid wastes; effectiveness limited by depth of mixing; arsenic mobility may increase; not readily implementable due to steep topography; not applicable because waste are near neutral in pH.
	Physical/ Chemical Treatment	Soil Washing	Separate hazardous constituents from solid media via dissolution & precipitation.	Not effective for waste rock; potential exists to increase mobility by providing partial dissolution of contaminants; implementable; high cost.
		Acid Extraction	Mobilize hazardous constituents via acid leaching & recover by precipitation.	Effectiveness is questionable. Sulfides would only be acid soluble under extreme temperature & pressure; high cost.
		Alkaline Leaching	Use alkaline solution to leach contaminants from solid media in heap, vat, or agitated vessel.	Effectiveness not well documented for arsenic; not readily implementable; high cost.
		Fluidized Bed Reactor/Rotary Kiln/Multi-Health Kiln	Concentrate hazardous constituents into small volume by volatilization of metals & formation of metallic oxide particulates.	Further treatment required to treat process by-product. Potentially implementable; cost prohibitive.

TABLE 11 (Continued)
Response Technology Screening Summary
Bear Gulch Mine Complex

General Response Action	Response Technology	Process Option	Description	Screening Comment
EXCAVATION & TREATMENT (continued)	Physical/ Chemical Treatment (continued)	Vitrification	Extremely high temperature used to melt and/or volatilize all components of the solid media. Molten material containing contaminants is rapidly cooled to form vitrified, non-leachable product.	Not readily implementable for solid wastes; extensive treatability testing required; emission controls necessary; cost prohibitive.
IN-SITU TREATMENT	Physical/ Chemical Treatment	Lime Fixation	Mine waste treated in-situ with lime amendments to reduce mobility of metals.	Lime treatment effective for acid wastes; effectiveness limited by depth of mixing; arsenic mobility may increase; not readily implementable due to steep topography; not applicable because waste are near neutral in pH.
		Solidification	Solidifying agents used in conjunction with deep soil mixing techniques to promote a physical or chemical change in mobility of contaminants.	Extensive treatability testing required. Potentially implementable; cost prohibitive.
		Soil Flushing	Acid/base reagents or chelating agents injected into solid media to solubilize metals. Pregnant solution with contaminants is extracted using dewatering techniques.	Effectiveness unknown; innovative process currently in pilot stage.
	Thermal Treatment	Vitrification	Contaminated solid media subjected to extremely high temperature in-situ. Rapid cooling vitrifies material into non-leachable product.	Potentially implementable but would require extensive pilot testing; site layout not ideal at certain sites due to steep slopes and lack of adequate access; cost prohibitive.

Institutional controls involving access restrictions via fencing and/or land use controls do not achieve a clean-up goal, however. Access restrictions are ***retained*** to complement clean-up actions and will be combined with other process options.

6.1.3 ENGINEERING CONTROLS

Engineering controls are used to reduce the mobility of contaminants by establishing barriers that prevent contaminant exposure and migration. Engineering controls typically include containment, capping, runon/runoff controls, revegetation and/or disposal. Engineering controls generally do not reduce the volume or toxicity of hazardous materials.

6.1.3.1 Containment

Containment technologies are used as source control measures. These technologies are designed to eliminate direct contact and fugitive emissions from contaminated materials. In addition, such controls are used to divert and minimize infiltration of surface water/precipitation that may contribute to erosion and/or leachate formation. The cap or cover design is a function of the degree of hazard posed by the contaminated media and may vary from a simple soil cover to a multi-layered waste cap.

Capping is an appropriate alternative when contaminated materials are left in-situ. An on-situ capping design is dependent on the relative toxicity and mobility of the contaminants and demonstrated impacts to human health and/or environment. Capping is also an option when excavation and disposal or treatment actions are cost prohibitive. Capping of mine/mill wastes is a standard construction practice, uses standard equipment, and employs standard design methods.

Containment process options including soil cover are ***retained*** for further analysis because soil cover can eliminate direct contact and ingestion pathways at the waste sites.

6.1.3.2 Surface Controls

Surface controls are used to minimize contaminant migration. Surface controls alone may not be appropriate in areas where direct human contact is a primary concern. In these instances, surface controls are commonly integrated with containment to provide further protection. Surface control process options are directed at controlling water and wind impacts on contaminated materials. These options include consolidation, grading, revegetation, and erosion controls.

Consolidation involves grouping wastes of similar type in a common area for more efficient management or treatment. Consolidation is important in areas where multiple smaller waste sources are present and wastes are in sensitive areas (e.g. floodplains).

Grading is used to reshape and compact waste areas in order to reduce slopes, manage the run-on/run-off and infiltration of surface water, and control erosion. Depending on site conditions, periodic maintenance may be necessary to control subsidence and erosion problems after closure.

Revegetation involves adding soil amendments to a limited depth in the waste in order to provide nutrients and organic materials to establish vegetation. In addition, neutralizing agents and/or additives to improve pH conditions and/or the water storage capacity of the waste may be appropriate. Revegetation is essential to controlling water and wind erosion processes and minimizing infiltration of water through plant evapotranspiration processes. Revegetation generally involves the selection of appropriate plant species, preparation of the seeding area, seeding and/or planting, mulching and/or

chemical stabilization, and fertilization. Depending on the success of revegetation, the site may require maintenance in order to establish a self-sustaining plant community.

Erosion protection includes using erosion resistant materials to control water and wind impact on the contaminated media surface. Processes include surface water diversions, application of mulch and natural or synthetic fabric mats, and rip rap. Erosion resistant materials are strategically placed based on knowledge of drainage area characteristics, slopes, vegetation types and densities, soil texture, and precipitation data.

Surface control process options ***grading, consolidation, revegetation, and erosion protection are retained*** for inclusion into response alternatives. These process options would not be effective in controlling the release of hazardous substances alone.

6.1.3.3 On-Site Disposal

On-site disposal can be used as a permanent source control measure. On-site disposal will require solid waste or hazardous waste repository design or a modification of these designs. The containment facility design will depend on the toxicity, mobility and type of material requiring disposal.

This reclamation technology involves placing the untreated or treated contaminated materials in an engineered repository located on-site. Design specifications could range from a simple, unlined, covered waste facility to a capped and lined facility with a leachate collection system.

On-site disposal technologies are retained for further analysis because a 1999 field investigation completed for the USDA-FS indicated that acceptable sites for construction and operation of a repository for containment of mine wastes are available on near-by National Forest System lands (Pioneer, 1999). The USDA-FS has chosen a location for a central on-site repository, the Prichard/Beaver repository. This repository site is located in the Prichard/Beaver drainages within about 12 miles of the Complex.

6.1.3.4 Off-site Disposal

Off-site disposal involves excavating contaminated materials and transporting them to an existing engineered repository permitted to accept such materials. Off-site disposal options include a RCRA-permitted repository or a solid waste landfill. Materials classified as hazardous waste as defined in RCRA would require disposal in a RCRA-permitted facility. Less toxic materials could possibly be disposed in a permitted solid waste or sanitary landfill.

Off-site disposal at a solid waste facility or RCRA-permitted facility is not retained because the USDA-FS has made an administrative policy decision that does not allow disposal of mining wastes at a solid waste facility and disposal at a RCRA facility would be cost prohibitive. Also in this regard, there is a general reluctance of solid waste facilities to accept mining wastes and there remains a liability to the government if such a facility was used.

6.1.4 EXCAVATION AND TREATMENT

Excavation and treatment processes involve the removal of the contaminated materials and subsequent treatment to reduce toxicity and/or volume. Treatment processes may involve a variety of techniques including chemical, physical or thermal methods. These methods are used to concentrate metal

contaminants for additional treatment or recovery of economic constituents or to reduce the toxicity of hazardous constituents.

6.1.4.1 Reprocessing

Reprocessing involves excavation and transportation of contaminated materials to an existing mill or smelter for processing and recovery of valuable metals. Applicability of this option is dependent on the concentration of economically viable elements and the ability and willingness of the facility to process the material and dispose of the waste. Reprocessing of mine/mill wastes from outside sources is not commonly practiced due to the low concentrations of metals in source materials, operating permits limiting processing of off-site materials, and liability issues. ***Reprocessing is not retained*** for further evaluation.

6.1.4.2 Fixation/Stabilization

Fixation/stabilization technologies employ treatment processes that chemically alter the contaminant to reduce its mobility or toxicity (fixation) or physically treat the contaminant by encapsulating it with an inert material (stabilization). The technology involves mixing materials with binding agents under specific conditions to form a stable matrix. For inorganic contaminants, fixation/stabilization employs a reagent or combination of reagents to promote a chemical and/or physical change in order to reduce the mobility. Fixation of mine wastes with additives that raise the pH of the waste have been used widely in the last 15 years to reduce the mobility of metals. These additives include lime (calcium oxide), limestone (calcium carbonate), and calcium hydroxide. The in-situ process uses both surface and deep mixing techniques to achieve the best integration of the fixation agents with contaminated media. Stabilization processes commonly use pozzolan/cement as additives.

Fixation with lime is not retained for further consideration because of proximity of tailings to Bear Gulch Creek and excavation of tailings is not necessary for effective treatment and revegetation. ***Stabilization using pozzolans is not retained*** due to higher costs associated with the process.

6.1.4.3 Physical/Chemical Treatment

Physical treatment processes use physical characteristics to concentrate constituents into a smaller volume for disposal or further treatment. Chemical treatment processes treat contaminants by adding a chemical reagent that removes or fixates the contaminant. Chemical treatment processes reduce toxicity and/or mobility of contaminants in solid media. Chemical treatment processes generally work in conjunction with physical processes to flush the contaminated media with water, acids, bases, or surfactants. Potentially applicable physical/chemical treatment processes include soil washing, acid extraction, and alkaline leaching.

Soil washing is a treatment process that consists of washing the contaminated media with water in a heap, vat, or agitated vessel to dissolve water-soluble contaminants. Soil washing requires that contaminants be readily soluble in water and sized sufficiently small so that dissolution can be achieved in a practical retention time. Dissolved metal constituents contained in the wash solution are precipitated as insoluble compounds, and the treated solids are dewatered before additional treatment or disposal. Precipitates form a sludge that may require additional treatment such as dewatering or stabilization prior to disposal.

Acid extraction involves applying an acidic solution to the contaminated media in a heap, vat, or agitated vessel. Depending on temperature, pressure, and acid concentration, varying quantities of the metal

constituents present in the contaminated media would be dissolved. A broader range of contaminants can be expected to be acid soluble at ambient conditions using acid extraction versus soil washing; however, sulfide compounds may only be acid soluble under extreme conditions of temperature and pressure. Dissolved contaminants are precipitated prior to additional treatment and/or disposal.

Alkaline leaching is similar to acid extraction in which a leaching solution, i.e. ammonia, lime, or caustic soda, is applied to the contaminated media in a heap, vat, or agitated vessel. Alkaline leaching is potentially effective for leaching the majority of metals from contaminated media; however, removal of arsenic is not well documented.

These process options are ***not retained*** for further consideration due to associated high costs.

6.1.4.4 Thermal Treatment

Thermal treatment technologies apply heat to contaminated media in order to volatilize and oxidize metals. This process renders the contaminated media amenable to additional processing or it produces an inert product via vitrification. Potentially applicable thermal processes that volatilize metals and form metallic oxide particulates include the fluidized bed reactor, rotary kiln, and multi-hearth kiln. High temperature vitrification is another thermal treatment technology that essentially melts or volatilizes the contaminated media. Volatile contaminants and gaseous oxides of sulfur are driven off as gases and the non-volatile component is vitrified when it cools. ***Thermal treatment is not retained*** for further consideration due to its high cost.

6.1.5 IN-SITU TREATMENT

In-situ treatment involves treating contaminated materials in place with the objective of reducing mobility and toxicity of problem constituents. In-situ treatments provide less control than ex-situ treatment options because mixing of additives is less efficient. In-situ treatment technologies include physical/chemical and thermal treatment processes. Physical/chemical treatment technologies include stabilization/solidification and soil flushing while thermal treatment technology relies on the process of vitrification.

6.1.5.1 Physical/Chemical Treatment

In-situ stabilization/solidification is similar to conventional stabilization in that a solidifying or chemical precipitating agent (or combination of agents) is used to create a chemical or physical change in the mobility and/or toxicity of the contaminants. Treating mine wastes with additives that raise the pH of the waste have been used widely in the last 25 years to reduce the mobility of metals. These additives include lime (calcium oxide), limestone (calcium carbonate), and calcium hydroxide. The in-situ process uses both surface and deep mixing techniques to achieve the best integration of the solidifying agents with the contaminated media. ***In-situ fixation with lime is not retained*** for further consideration because the pH of the waste materials is near neutral and alkaline treatment would not further limit metal mobility.

Soil flushing is a process that injects an acidic or basic reagent or chelating agent into contaminated media to solubilize metals. Dissolved metals are extracted using established dewatering techniques, and the extracted solution is treated to recover metals or is disposed as aqueous waste. Low permeability materials may hinder thorough circulation, solution reaction, and ultimate recovery. Currently, soil flushing has only been demonstrated at the pilot scale. In-situ soil flushing is ***not retained*** for further

consideration because of the difficulty of implementation of this technology at the widely dispersed dumps at the Complex, the proximity of Bear Gulch Creek, and high cost.

6.1.5.2 Thermal Treatment

In-situ vitrification is a process used to melt contaminated solid media to immobilize metals into a glass-like, inert, non-leachable solid matrix. Vitrification requires significant energy to generate sufficient current to force the solid media to act as a continuous electrical conductor. This technology is seriously inhibited by high-moisture content. Gases generated by the process must be collected and treated in an off-gas treatment system. In-situ vitrification has only been demonstrated at pilot scale, and treatment costs are extremely high compared to other treatment technologies. This process option is ***not retained*** for further consideration because of the difficulty of implementation and high cost.

6.2 REMOVAL ACTION ALTERNATIVE DEVELOPMENT

The most promising technologies and process options that were retained through the screening process are summarized in Table 12. These options appear to be effective and readily implementable for a reasonable cost and will be used to develop removal action alternatives for further consideration.

TABLE 12
Technologies and Process Options Retained From Screening
Bear Gulch Mine Complex

General Response Action	Response Technology	Process Option
No Action	None	None
Institutional Controls	Access Restrictions	Road Closures
		Land Use Controls
Engineering Controls	Containment	Soil Cover
	Surface Controls	Consolidation
		Revegetation
		Erosion Protection/Run-on Control
	On-Site Disposal	Composite Cover

EPA guidance for non-time-critical removal actions suggests that only the most qualified technologies that apply to the media or source of contamination be evaluated in detail in the EE/CA. Using this guidance, a limited number of alternatives were assembled from the 8 process options for further consideration. Table 13 lists four removal action alternatives that will be considered in the detailed analysis (Section 7.0). Alternatives were developed by combining process options so that each alternative offered a distinct benefit over another alternative. The assembled alternatives cover a reasonable range of costs, an important factor that will be considered in the detailed analysis. Also listed in Table 13 are the process options and technologies that define each alternative.

TABLE 13
Removal Action Alternatives
Bear Gulch Mine Complex

Alternative	Response Technology/Process Options
1. No Action	None
2. Improve Vegetation on, and Limit Access to, Waste Rock Dumps	Access Restrictions; Erosion Protection/Run-On Control, Revegetation
3. Consolidate Tailings Out of the 100-Year Floodplain; Improve Vegetation on, and Limit Access to, Waste Rock Dumps	Access Restrictions; Erosion Protection/Run-On Control; Revegetation; Consolidation; Soil Cover
4. Remove Tailings and Accessible Waste Rock Dumps to a Central Repository; Improve Vegetation on, and Limit Access to, Waste Rock Dumps	Access Restrictions; Erosion Protection/Run-On Control; Revegetation; On-Site Disposal with Composite Cover

A brief description of each of the alternatives is presented below.

1. *No Action* - No action requires no removal, treatment, or containment of waste. Site conditions remain unaltered and risks to human health and the environment persist.

2. *Improve Vegetation on, and Limit Access to, Waste Rock Dumps* – This alternative involves improving vegetation on and restricting access to the waste rock dumps by closing roads and trails.

3. *Consolidate Tailings Out of the 100-Year Floodplain; Improve Vegetation on, and Limit Access to, Waste Rock Dumps* – Tailings will be consolidated on-site in an area located on the north side of Bear Gulch above the 100-year floodplain. Vegetation on waste rock dumps would be improved and roads and trails would be closed in accordance with Alternative 2.

4. *Remove Tailings and Accessible Waste Rock Dumps to a Central Repository; Improve Vegetation on, and Limit Access to, Waste Rock Dumps* – Tailings and waste rock will be removed to the central USDS-FS repository. Waste rock would be removed from the accessible dumps at the Orofino and Silver Scott Mines. Vegetation will be improved on inaccessible waste rock dumps and access to the dumps will be restricted by closing roads and trails in accordance with Alternative 2.

7.0 DETAILED ANALYSIS OF REMOVAL ALTERNATIVES

The four removal alternatives developed in the previous section are analyzed in detail in this section. Removal alternatives represent a range of potential actions that can meet, to some degree, RAOs for the project and achieve distinct levels of protectiveness to human health and the environment for a reasonable range of costs.

7.1 EVALUATION CRITERIA

Three criteria are used to evaluate removal action alternatives in accordance with EPA guidance (EPA, 1993):

1. Effectiveness
2. Implementability
3. Cost

7.1.1 EFFECTIVENESS

According to EPA guidance for non-time-critical removal actions (EPA, 1993), the effectiveness of an alternative should be evaluated by the following criteria: overall protection of human health and the environment; compliance with ARARs; long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; and, short-term effectiveness. The ability of each alternative to meet RAOs is considered when evaluating these criteria.

A preliminary list of ARARs for the project is presented in Appendix A. These ARARs are grouped into both federal and state ARARs and subdivided into contaminant-specific, location-specific, and action-specific categories or groups. Federal ARARs are being proposed for the site by the USDA-FS. The State of Idaho Department of Environmental Quality identified State ARARs in a general form for the project, but has not yet provided site specific ARARs. The ARAR discussion for the four alternatives evaluated in detail in this EE/CA addresses the general degree of meeting ARARs.

7.1.2 IMPLEMENTABILITY

Implementability addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. Technical feasibility considerations include the applicability of the alternative to the waste source, availability of the required equipment, expertise to implement the alternative, and overall reliability of the alternative. Implementability also considers the appropriateness of combinations of alternatives based on site-specific conditions. Administrative feasibility evaluates logistical and scheduling constraints.

7.1.3 COST

Evaluation of cost consists of developing conservative cost estimates based on the identified work items required for each alternative. These costs do not necessarily represent the cost that may be incurred during construction of the alternative because many design details are preliminary at this stage. However, a similar set of assumptions is used for all the alternatives so that the relative differences in cost between alternatives are represented. Unit costs were developed by analyzing data available from USDA-FS and nationally published cost estimating guides. Where possible, cost data incorporate actual operating and unit costs that have been incurred during similar reclamation projects. Unit costs are

based on assessments of materials handling and procurement, site conditions, administrative and engineering costs, and contingency.

In addition to the capital costs discussed above, post-removal site control (PRSC) costs are estimated for each alternative. These PRSC costs were estimated using reasonable assumptions for potential maintenance of each of the alternatives. Because it is difficult to determine the actual maintenance that will be needed to ensure that an alternative is successful (due to the fact that the reclamation alternatives considered for this project depend to a large extent on the success of revegetation), PRSC requirements tend to be based on the relative difference in perceived maintenance between alternatives. This is a subjective evaluation that relies on professional judgment rather than predictable events.

Assumptions used to determine the average annual cost of PRSC are presented for each alternative. Average annual PRSC costs are estimated for a 30-year period; the present worth for PRSC is calculated using a discount rate factor of 4.9% (OSWER, 1993). The total estimated project cost for each alternative is the sum of the estimated capital cost, the estimated present worth PRSC cost, and engineering design and construction oversight costs which are calculated as a percentage of the estimated capital cost.

Costs presented in this section are based on tailings and waste rock volumes estimated by Maxim (2003). Detailed unit cost spreadsheets are presented in Appendix B.

7.2 SAFETY HAZARD MITIGATION

Except for the no action alternative, mitigating safety hazards by closing mine openings at each site will be performed in conjunction with treatment and removal action components associated with each alternative. Safety hazard mitigation will involve closing open adits and stopes identified in the Bear Gulch Mine Complex by installing bat-friendly metal grates, backfilling with soil (if the opening is accessible by haul truck), blasting and filling with rock, or filling with polyurethane foam (if the opening is not accessible by heavy equipment). A separate fixed cost to close mine openings is included as a line item to the alternative cost estimates in Appendix B.

7.3 DETAILED ANALYSIS OF ALTERNATIVES

7.3.1 ALTERNATIVE NO. 1 - NO ACTION

The no action alternative involves leaving the Complex as is. No reclamation would be done to control contaminant migration or to reduce toxicity or volume. Limited surface water monitoring would be performed under this alternative.

7.3.1.1 Effectiveness

The no action alternative neither addresses surface water impacts, nor provides any controls on contaminant migration to surface water and groundwater. Direct contact with mine waste by humans and animals will not be controlled.

Toxicity, mobility, and volume of contaminants would not be reduced under No Action, and protection of the environment would not be achieved. Surface water contaminant-specific ARARs are currently not being met in Bear Gulch Creek. The creek will continue to cut through tailings, releasing metals

directly to surface water and sediment, and surface water runoff will continue to erode waste rock dumps. Other location- and action-specific ARARs are likely met under no action.

7.3.1.2 Implementability

Implementing this alternative is both technically and administratively feasible.

7.3.1.3 Cost

No capital costs would be incurred under this alternative. A limited surface water monitoring program would be conducted for Bear Gulch Creek. Surface water samples would be collected annually at stations upstream and downstream of the Bear Top/Orofino Mill Site during low flow. The annual cost of surface water monitoring, including reporting, is estimated to be $2,500, with PRSC costs for annual surface water monitoring estimated at about $47,000 (Appendix B).

7.3.2 ALTERNATIVE NO. 2 - IMPROVE VEGETATION ON, AND LIMIT ACCESS TO, WASTE ROCK DUMPS

This alternative involves improving vegetation on waste rock dumps by planting native trees and shrubs on steep, inaccessible slopes (Figure 4). Roads and trails to waste rock dumps would be closed to limit access. A description of the alternative is presented below, followed by the detailed analysis.

7.3.2.1 Alternative Description

- *Clearing and Grubbing:* Portions of upgraded roads will be cleared and grubbed.

- *Protect Historic Features:* Temporary safety fence and flagging, or cut timbers will be used to designate historic features that are to be protected during construction. We assume two historic features would be protected as part of this alternative.

- *Road Upgrades and Construction:* Road upgrade work necessary to conduct a removal action at the Complex includes regrading, improving drainage, increasing width, and adding turnouts on selected portions of FS Road 938, as well as removing a dilapidated bridge on FS Road 938 just west of the Bear Top/Orofino Mill Site and replacing it with a culvert (Figure 4).

  Alternative 2 would require upgrading about four miles of FS Road 938 and about 2.5 miles of 4-wheel drive road. The travel width of 4-wheel drive road would be 12 feet once it is improved.

- *Sediment Controls:* Sediment produced by upgrading and constructing roads will be controlled by applying best management practices (BMPs) at locations downslope of road improvements constructed in sensitive areas such as wetlands and stream crossings. Dust created during project construction would be mitigated using BMPs.

- *Prepare Planting Areas and Plant Native Trees and Shrubs On Waste Rock Dumps*: Planting areas would be prepared at the Ione, Silver Scott, Bear Top, and Orofino Mines either by hand or by specialized heavy equipment. The Lower Workings of the Ione Mine would not be treated because waste sample results (Maxim, 2003) indicate this waste does not pose any risk to human health or the environment. Native trees and shrubs would be planted in prepared planting areas. The purpose of native plantings is to provide breaks in the slopes of the waste rock dumps to enhance slope stability and to provide a seed source to enhance natural revegetation processes.

- *Install French Drains and Infiltration Basins*: French drains will be installed at the five flowing adits to allow free drainage of water from the adits and infiltration basins will be constructed near the mouth of each flowing adit to minimize surface discharge.

- *Obliterate/Close Access Roads and Trails:* Access roads and trails designated by the Forest Service would be recontoured and reclaimed, or access would be restricted by road closure devices such as gates or earthen berms. Total estimated length of roads and trails to be recontoured and reclaimed is 2.5 miles, and the estimated number of road closure structures is two.

- *Fertilize, Seed With Native Species and Mulch Disturbed Areas:* Areas disturbed by construction would be fertilized, seeded and mulched to establish vegetation. Disturbed areas would include obliterated roads.

- *PRSC:* Vegetation established on disturbed areas and road/trail closures would be monitored and maintained.

7.3.2.2 Effectiveness

Alternative 2 would improve slope stability and would reduce erosion of waste rock. Limiting access to waste rock dumps would be effective in limiting human exposure to waste rock. Limiting access to the tailings would be difficult, as the main road would need to remain open for private access. This alternative would not be effective in controlling erosion or human exposure to the tailings material present at the Bear Top/Orofino Mill Site because the tailings would not be addressed.

❖ *OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT*

Alternative 2 provides a minimal measure of control over human exposure to waste rock. It reduces risk to human health and the environment by limiting access to a portion of the waste (waste rock dumps make up about 33% of the total area of exposed mine waste) and by planting vegetation to improve slope stability, and reduces the potential for further erosion and migration of contaminants from exposed waste rock dumps located in Bear Gulch by stabilizing them with vegetation. Alternative 2 does not provide any control over human and environmental exposures to tailings.

Exposure to adit discharges would continue, but this exposure would be limited due to, access restrictions, low flows, and the efforts to eliminate surface discharge.

Project objectives would only be partially met under this alternative. By closing adits and stopes, and by improving vegetation on the waste rock dumps, safety hazards would be eliminated and erosion of waste rock would be reduced. By obliterating and/or closing roads and trails that lead to waste rock dumps, human exposure to COCs would be reduced. The project objective to reduce or eliminate hazards presented by sediment and metals contamination to Bear Gulch Creek would not be met because the tailings at the Bear Top/Orofino Mill Site would not be addressed under this alternative.

❖ *COMPLIANCE WITH ARARS*

For Alternative 2, the primary contaminant-specific ARARs that apply include surface water and groundwater quality standards. Surface water quality is not expected to improve if this alternative is implemented, as surface water in Bear Gulch will continue to flow over and through tailings. Because tailings will remain within the floodplain of Bear Gulch Creek, overbank flow conditions may cause erosion and transport of tailings into the creek.

No effect on groundwater quality is expected if Alternative 2 is implemented. It is not know if groundwater standards are exceeded under current conditions.

Location-specific ARARs are expected to be met. No sensitive or rare plants are known to exist in the project area that would be disturbed by implementing this alternative. Threatened and endangered species present in the vicinity of the project include bull trout, Canada lynx, and bald eagle, although no critical habitat has been designated or proposed for threatened and endangered species in the project area. Road improvements associated with this alternative include installing a temporary bridge over Bear Gulch Creek and widening FS Road 938. Any impacts to bull trout from road improvements will be mitigated using BMPs during construction. Other than minor road improvements, Alternative 2 only addresses the waste rock dumps, so no impacts to bull trout, Canada lynx, and bald eagle are expected over current conditions as a result of implementing this alternative.

Other location-specific ARARs will be protected through substantive compliance with the requirements of laws related to streambeds and wetlands. The Floodplain and Floodway Management Act does not directly apply because Bear Gulch is not in a designated 100-year floodplain. However, tailings will be left in the floodplain of Bear Gulch.

Because mine wastes are derived from the beneficiation and extraction of ores, these wastes generally are exempt from federal and state regulation under RCRA as a hazardous waste (42 U.S.C. 6921 (b) (3) (A)(iii)(1994)). Location specific ARARs associated with solid waste regulations do not apply to this alternative.

Only some action-specific ARARs would be met under Alternative 2. Action-specific ARARs for storm water runoff will be complied with using BMPs. Relevant and appropriate revegetation requirements contained in the Surface Mining Control and Reclamation Act would not be met as the relatively sparse density of plantings would not meet the cover requirements of this act. However, native species will be selected for revegetation and BMPs for planting, mulching, soil amendments, control of noxious weeds, and erosion control will be followed under this alternative.

Occupational Safety and Health Administration requirements will be met by requiring appropriate safety training for all on-site workers during the construction phase. Site activities will be conducted under the guidance of a Health and Safety Plan for the site per OSHA 29 CFR 1910.120. Site personnel will have completed 40-hour hazardous waste operations and emergency response training and would be current with the 8-hour annual refresher training as required by OSHA 29 CFR 1910.120.

❖ *LONG-TERM EFFECTIVENESS AND PERMANENCE*

Long-term effectiveness and permanence is only partially met by this alternative. Once vegetation is established on the waste rock dumps and maintained for several years it should persist over the long-term, although it's effectiveness in reducing erosion will be limited because a complete vegetation cover will not be established on the dumps. Roads that have been closed by obliteration and revegetation will

be effective in the long-term and permanent, but roads closed using man-made structures will only remain effective as long as those structures are maintained.

PRSC involving monitoring and maintenance will be conducted at revegetated roads and dumps. Monitoring and maintenance will improve the opportunity to achieve long-term effectiveness.

❖ *REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT*

There will be some reduction in mobility of waste rock, but no reduction of toxicity or volume under this alternative. There will be no reduction in toxicity, mobility or volume of tailings. Bear Gulch Creek will continue to cut through the tailings, releasing metals directly to surface water and generating sediment.

❖ *SHORT-TERM EFFECTIVENESS*

This alternative should allow completion in a single construction season of not more than 30 days. Therefore, impacts associated with construction activities are considered short-term, and should not significantly impact human health. On-site workers will be protected by following a site specific Health and Safety Plan, employing appropriate personal protective equipment, and by following proper operating and safety procedures.

A significant short-term impact to the surrounding area and wildlife involves increased vehicle traffic and temporary closures of some forest roads. An increase in traffic will occur during mobilization and demobilization of construction equipment. It is estimated that about 7 pieces of construction equipment will be mobilized to the site for the in-situ treatment action. Equipment will include an excavator (1), backhoe (1), haul trucks (3), transports (1) and miscellaneous light duty trucks (1). Materials will be supplied by transports and trucks that will periodically travel to the site. An estimate of less than one truck or transport trip per day is anticipated for the construction season.

Short-term road closures in the project area may be necessary, limiting access to the forest. Increased traffic may impact wildlife by either changing daily migration patterns or exposing wildlife to a higher potential for injury or death due to collisions with vehicles.

Road improvements needed to implement this alternative may have some short-term impacts on the watershed. Increased sedimentation may result from road improvements due to an increased sediment load from deeper and wider borrow ditches and widened existing roads. These short-term impacts will be minimized by using BMPs, and should be limited to one growing season, after which vegetation should be established. Potential impacts will be mitigated by implementing BMPs for stormwater runoff, and an aggressive revegetation effort on improved roads.

7.3.2.3 Implementability

Alternative 2 is both technically and administratively feasible. Key project components such as equipment, materials, and construction expertise are available and would allow the timely implementation and successful execution of the alternative.

7.3.2.4 Cost

The detailed cost analysis for Alternative 2 is included in Appendix B. The PRSC costs were assumed to include minimal hand labor maintenance on an annual basis and periodic seed and fertilizer application.

Total cost for this alternative is about $410,000. About 29% of this cost is associated with closing mine openings and about 10% of this cost is associated with improving vegetation on waste rock dumps. PRSC costs associated with maintaining the treated area amounts to about $53,000 in present worth.

7.3.3 ALTERNATIVE NO. 3 – CONSOLIDATE TAILINGS OUT OF THE 100-YEAR FLOODPLAIN; IMPROVE VEGETATION ON, AND LIMIT ACCESS TO, WASTE ROCK DUMPS

This alternative involves consolidating tailings present at the Bear Top/Orofino Mill Site to an adjacent site located on National Forest System lands on the north side of the Bear Gulch drainage, above the 100-year floodplain. The streambed of Bear Gulch Creek will also be removed in conjunction with tailings removal and the streambed and streambanks will be reconstructed. Vegetation would be improved on the waste rock dumps and roads to the waste rock dumps would be closed in accordance with Alternative 2.

Figure 5 shows the proposed consolidation site. A description of the alternative is presented below, followed by the detailed analysis.

7.3.3.1 Alternative Description

In addition to closure of safety hazards described in Section 7.2, the following work activities are included in the construction of Alternative 3:

- *Clearing and Grubbing:* Clear and grub the tailings area.

- *Protect Historic Features:* Temporary safety fence and flagging or cut timbers will be used to designate historic features that are to be protected during construction. It was assumed four historic features would be protected as part of this alternative.

- *Remove and Dispose of Non-Historic Debris*: Combustible debris will be separated from non-combustible debris. Combustibles will be stockpiled at pre-determined locations. Non-combustibles will be disposed at a licensed solid waste disposal facility except for concrete fragments. Concrete fragments will be broken into smaller pieces and buried on-site. Combustibles will be burned by the Forest Service. It was assumed four tons of debris would be separated as part of this alternative.

- *Sediment Controls:* Sediment produced by upgrading and constructing roads and removing tailings will be controlled by installing BMPs at locations downslope of the road improvements constructed in sensitive areas such as wetlands and stream crossings, and downslope of tailings removal areas. Dust created during project construction would be mitigated using BMPs.

- *Road Upgrades and Construction:* Road upgrade work necessary under Alternative 3 would include those required for Alternative 2 as well as constructing two access roads to the Bear Top/Orofino Mill Site and two access roads to the consolidation site. A temporary bridge will be installed to access tailings south of Bear Gulch Creek (Figure 5).

  The two access roads to the Bear Top/Orofino Mill Site, and the two access roads to the consolidation site would have total lengths of 60 feet and 150 feet, respectively, and widths of 14 feet. New road construction would include clearing and grubbing a road width of 16 feet and stripping and stockpiling topsoil along the road. Dozer grading would be used to establish the travel width. No turnouts would be required on the constructed roads. Installation and removal of a

temporary bridge would be required to access tailings south of Bear Gulch Creek. For cost estimating purposes, it was assumed this temporary bridge would be furnished by the USDA-FS.

Total new disturbance associated with road upgrades and construction under Alternative 3 is expected to be 0.07 acres (ac).

- *Construct Consolidation Site With Soil Cover:* Tailings consolidation would require the following items:

  - Clearing and grubbing the consolidation site footprint;
  - Excavating and stockpiling one foot of topsoil from the disturbance area;
  - Excavating subsoil to a depth of four feet within the footprint of the consolidation site.
  - Compacting the subgrade of the consolidation to a specified density;
  - Placing and compacting the tailings;
  - Grading and shaping the tailings to obtain suitable slopes and subgrade for cover construction;
  - Constructing a soil cover using soil salvaged from the consolidation site;
  - Constructing runon and runoff control ditches around the perimeter of the consolidation site; and,
  - Applying appropriate fertilizer, seed, and mulch on the completed soil cover.

The area of the consolidation site footprint would cover approximately 1.4 ac.

- *Construct and Remove Surface Water Diversion System:* Temporary surface water diversion will be required to remove saturated tailings and one-foot of saturated native soil from the tailings area. Diversion will involve piping surface water around the excavation area. The diversion pipe length will be about 1,100 feet.

- *Excavate/Load/Haul Waste:* Excavate, load and haul tailings from the tailings area. One-foot of over-excavation will be performed in the removal area for a total of about 17,080 bank cubic yards. A bank cubic yard (bcy) is the volume of material before excavation and does not include a swell factor. Waste will be excavated using scrapers and hauled to the consolidation site.

- *Load/Haul/Place/Compact Backfill:* Backfill would be obtained from a nearby borrow site, if suitable sources of backfill are available locally, or would be obtained from a known source adjacent to the USDS-FS repository. The backfill would be hauled, placed and compacted in the tailings removal area to match surrounding topography. The total volume of backfill required is estimated to be about 12,800 bcy.

- *Amend Backfill With Compost:* The backfilled tailings removal area will be amended with compost to a depth of four inches. The total area of backfill to be amended with compost will be about 3.5 ac.

- *Reconstruct Bear Gulch Creek:* Reconstruct the streambed and streambanks of Bear Gulch Creek. The length of stream channel requiring reconstruction totals about 1,000 feet. Reconstruction will consist of placing streambed gravel and constructing fabric-wrapped streambanks. The new stream channel will consist of riffles, runs and pools and approximate its present sinuosity.

- *Prepare Planting Areas and Plant Native Trees and Shrubs On Waste Rock Dumps*: This alternative would follow the same approach for planting native trees and shrubs as described for Alternative 2.

- *Install French Drains and Infiltration Basins*: French drains will be installed at the five flowing adits to allow free drainage of water from the adits and infiltration basins will be constructed near the mouth of each flowing adit to minimize surface discharge.

- *Obliterate/Close Access Roads and Trails:* This alternative would follow the same approach for obliterating and closing roads and trails as described for Alternative 2.

- *Fertilize, Seed With Native Species and Mulch Disturbed Areas:* Areas disturbed by construction would be fertilized, seeded and mulched to establish vegetation. Disturbed areas would include obliterated roads.

- *PRSC*: Vegetation established on waste removal, vegetation improvement, and disturbed areas would be monitored and maintained.

7.3.3.2 Effectiveness

On-site consolidation of excavated tailings would be an effective alternative for reducing contaminants at the site. The consolidation site would be constructed in an area located proximal to the removal area, but outside the 100-year floodplain. No action would be taken on tailings deposited downstream of the removal area along Bear Gulch Creek. As with Alternative 2, this alternative would improve slope stability and would reduce erosion of waste rock.

❖ *OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT*

By consolidating tailings out of the floodplain, Alternative 3 removes and isolates about 27% of the volume of waste present in the complex and reclaims about 3.2 acres (67%) of the area in the Complex covered by COCs. Tailings, mixed tailings, and concentrates that contain the highest concentrations of COCs are consolidated, covered and protected from erosion, preventing direct contact and ingestion pathways to humans and wildlife. Alternative 3 reduces risk to human health and the environment in the tailings removal area and eliminates the potential for further erosion and migration of contaminants from the tailings source area into Bear Gulch Creek.

Alternative 3 provides the same measure of control of exposure to waste rock as Alternative 2. It reduces risk to human health and the environment by limiting access to the waste, and reduces the potential for further erosion and migration of contaminants from exposed waste rock dumps located in Bear Gulch by stabilizing them with vegetation. Residual risk at the waste rock dumps from lead remains at the dump sites, but exposure to lead in these wastes is reduced to humans by closing roads and trails that lead to these wastes.

Exposure to adit discharges would continue, but this exposure would be limited due to access restrictions, low flows, and the efforts to eliminate surface discharges. By closing adits and stopes, physical safety hazards would be eliminated.

Most project objectives would be met under this alternative. Although unlikely, flood events greater than the 100-year event may expose the consolidation site to erosion, and potentially allow re-

entrainment of tailings into Bear Gulch Creek if the soil cover fails. Re-entrainment of tailings into Bear Gulch would adversely affect aquatic health and habitat.

❖ *COMPLIANCE WITH ARARS*

Compliance with contaminant-specific ARARs should be achieved for any discharges released to surface water after removals are complete. Removing the tailings is not expected to result in full compliance with contaminant-specific ARARs in Bear Gulch because other sources of metals will remain in place downstream of the tailings. However, it is expected that removal, will have a significant impact in meeting surface water contaminant-specific ARARs.

Because groundwater has not been investigated, it is not known whether groundwater quality is impacted. Removal of tailings, however, should not degrade groundwater quality and will likely provide a positive effect and improvement in water quality beneath the removal areas. Groundwater quality will not be changed from current conditions at the waste rock dumps.

Contaminant-specific ARARs for ambient air are expected to be met under this alternative because tailings will be covered with soil and removal areas revegetated. Dust generated during construction will be managed using BMPs.

Location-specific ARARs at the tailings removal site are expected to be met to a substantial degree. There are no known historic or archaeological resources in the vicinity of the removal areas or the proposed consolidation site.

No sensitive or rare plants are known to exist in the project area that would be disturbed by implementing this alternative. Threatened and endangered species present in the vicinity of the project include bull trout, Canada lynx, and bald eagle, although no critical habitat has been designated or proposed for threatened and endangered species in the project area. Road improvements associated with this alternative include installing a temporary bridge over Bear Gulch Creek and widening FS Road 938. Any impacts to bull trout from road improvements will be mitigated using BMPs during construction. Impacts to bull trout from removal and reconstruction of 1,000 feet of Bear Gulch Creek will be mitigated through BMPs, including limiting the stream removal and construction work to avoid spawning periods. Construction and reclamation activities at the removal areas and consolidation site will be completed in a relatively short period of time, limiting impacts to Canada lynx and bald eagle. Maintenance of permanent facilities (the consolidation site) will not require a level of activity that is greater than that existing under current conditions.

Other location-specific ARARs will be met through substantive compliance with the requirements of laws related to streambeds, floodplains, and wetlands. The Floodplain and Floodway Management Act will be complied with because no response activities will be conducted in a designated 100-year floodplain. Streambanks and the stream channel in the tailings removal area will be reconstructed with earth and natural materials and sufficiently protected with erosion control techniques so that the bed and banks are protected from flood erosion. All disturbed areas will be managed during construction to minimize erosion. Location-specific ARARs derived from the Idaho Solid Waste Management Act and regulations will be complied with at the repository site.

Action-specific ARARs are expected to be met by this alternative. Action-specific ARARs for storm water runoff will be complied with through the use of BMPs at the tailings removal areas and at the consolidation site. No facilities require a discharge of waste to the environment. Substantive requirements of the Idaho Solid Waste Management Act will be met at the consolidation site through

design criteria. Because mine wastes are derived from the beneficiation and extraction of ores, tailings generally are exempt from federal and state regulation under RCRA as a hazardous waste (42 U.S.C. 6921 (b) (3) (A)(iii)(1994).

Revegetation requirements contained in the Surface Mining Control and Reclamation Act would be substantively met at the tailings removal and consolidation sites by using primarily native species and matching species to surrounding habitat types. BMPs for seeding, planting, mulching, soil amendments, control of noxious weeds, and erosion control will also be followed under this alternative. Other requirements for treating surface drainage, sediment control, construction and maintenance of sedimentation ponds, discharges from sedimentation ponds, and provisions for groundwater will be met by using best available technologies (BAT).

Action-specific State of Idaho air quality regulations related to dust suppression and control during construction activities will be met using BMPs.

Occupational Safety and Health Administration requirements would be met by requiring appropriate safety training for all on-site workers during construction phase. Site activities would be conducted under the guidance of a Health and Safety Plan for the site per OSHA 29 CFR 1910.120. Site personnel will have completed 40-hour hazardous waste operations and emergency response training and would be current with the 8-hour annual refresher training as required by OSHA 29 CFR 1910.120.

❖ *LONG-TERM EFFECTIVENESS AND PERMANENCE*

Long-term effectiveness and permanence is partially met by this alternative because tailings will be removed and covered with soil although waste rock will remain. Tailings present in streambed sediments downstream of the removal area will remain, and long-term maintenance of this waste may be required.

Once vegetation is established on the reclaimed tailings area and on the waste rock dumps and maintained for several years it should persist over the long-term, although it's effectiveness in reducing erosion will be difficult to determine. Roads that have been closed by obliteration and revegetation will be effective in the long-term and permanent, but roads closed using man-made structures will only remain effective as long as those structures are maintained.

PRSC involving monitoring and maintenance will be conducted at the removal area, consolidation site, and vegetation improvement areas. Monitoring and maintenance will improve the chances for achieving long-term effectiveness.

❖ *REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT*

There will be some reduction in mobility but no reduction of toxicity or volume with this alternative. Mobility of contaminants will be essentially eliminated with regard to tailings by removing tailings from the floodplain and covering them with soil, although this effect will not be achieved through treatment of the wastes. Mobility of waste rock will be reduced to some extent due to improved vegetative cover.

❖ *SHORT-TERM EFFECTIVENESS*

This alternative should be completed in a single construction season of not more than 60 days. Therefore, impacts associated with construction activities are considered short-term, and should not significantly impact human health. On-site workers will be protected by following a site specific Health

and Safety Plan, employing appropriate personal protective equipment and by following proper operating and safety procedures.

The major short-term impact to the surrounding area and wildlife involves increased vehicle traffic and temporary closures of some forest roads. An increase in traffic will occur during mobilization and demobilization of construction equipment, during transport of waste to the consolidation site, and during transport of materials for backfill and topsoil. An estimated 14 pieces of construction equipment will be mobilized to the site to implement this removal action. Equipment will include bulldozers (2), excavators (1), backhoes (1), haul trucks (4), scrapers (2), transports (1), and miscellaneous light duty trucks (3). Materials will be supplied by transports and trucks that will periodically travel to the site. An estimate of one truck or transport trip per day is anticipated for the construction season. Increased traffic may impact wildlife by either changing daily migration patterns or exposing wildlife to a higher potential for injury or death due to collisions with vehicles.

Short-term road closures in the project area may be necessary, limiting access to the forest. To haul the estimated 20,500 cy of tailings and over-excavated native soil (adjusted for 20% swell) to the consolidation site, about 1,220 short, round-trip scraper trips (using self-propelled 14 cy capacity scrapers) will be made on FS Road No. 938. Using 25-ton haul trucks to haul the estimated 15,400 cy of backfill (adjusted for 20% swell) to the site from the borrow area, about 1,025 round-trip truck trips will be made on either local roads or the roads between the Complex and the USDS-FS repository. Assuming 30-ton transport trucks would be used to deliver the estimated 315 tons of compost for backfill amendment at the tailings removal area, about 11 truck trips will be made between the compost source and the Complex.

Short-term air quality impacts to the immediate environment may occur during excavation, hauling, and placement of wastes, backfill and compost incorporation. Dust control on designated haul routes is an expected requirement and control of fugitive dusts will utilize BMPs.

Road improvements needed to implement this alternative may have some short-term impacts on the watershed. Increased sedimentation may result from road improvements due to an increased sediment load from exposed widened roads and deeper and wider borrow ditches. These impacts will be mitigated by implementing BMPs for stormwater runoff.

7.3.3.3 Implementability

Consolidating tailings onsite and performing the other components of Alternative 3 are both technically and administratively feasible. Key project components such as equipment, materials, and construction expertise are available in the area. Availability will allow the timely implementation and successful execution of the alternative.

7.3.3.4 Cost

The detailed cost analysis for Alternative 3 is included in Appendix B. The total estimated cost for this alternative is about $1.54 million. Closure of mine openings account for 8% of the total cost, and construction of the consolidation site accounts for about 19% of the total cost. Waste removal costs account for about 7% of the total estimated cost. A haul cost of $5.30 per cubic yard waste was estimated. Backfill hauling and placement costs account for about 21% of the total estimated cost. For cost estimating purposes, it was assumed that backfill would be obtained from an area adjacent to the USDS-FS repository, about 12 miles by road from the consolidation site. If a more local source of backfill can be found, haul costs associated with this item could be reduced considerably. A haul cost of

$14.70 per cubic yard backfill was estimated. About 2% of the total cost is associated with improving vegetation on waste rock dumps and Bear Gulch Creek reconstruction costs account for 3% of the total estimated cost. PRSC costs associated with maintenance of this alternative total $65,800 in present worth.

7.3.4 ALTERNATIVE NO. 4 – REMOVE TAILINGS AND ACCESSIBLE WASTE ROCK DUMPS TO A CENTRAL REPOSITORY; IMPROVE VEGETATION ON, AND LIMIT ACCESS TO, WASTE ROCK DUMPS

This alternative involves removing tailings present at the Bear Top/Orofino Mill Site and waste rock present at the lower workings at the Orofino Mine and the upper and lower workings at the Silver Scott Mine to a central repository. The central USDS-FS repository is shown on Figure 1. The streambed of Bear Gulch Creek will also be removed in conjunction with tailings removal and the streambed and streambanks will be reconstructed. As with Alternative 2, vegetation will be improved on the inaccessible waste rock dumps and access to the dumps will be restricted by closing roads.

Figure 1 shows the haul route to the central repository and borrow area. The haul route would also be used to bring materials and transport equipment to the site. A plan view of the tailings removal area is shown in Figure 6. A description of the alternative is presented below, followed by the detailed analysis.

Alternative Description

In addition to closure of safety hazards described in Section 7.2, the following work items are included in the construction of Alternative No. 4:

- *Clearing and Grubbing:* Clear and grub the tailings area.

- *Protect Historic Features:* Temporary safety fence and flagging or cut timbers will be used to designate historic features that are to be protected during construction. It was assumed six historic features would be protected as part of this alternative.

- *Remove and Dispose of Non-Historic Debris*: Combustible debris will be separated from non-combustible debris. Combustibles will be stockpiled at pre-determined locations. Non-combustibles will be disposed at a licensed solid waste disposal facility except for concrete fragments. Concrete fragments will be broken into smaller pieces and buried on-site. Combustibles will be burned by the Forest Service. It was assumed six tons of debris would be separated as part of this alternative.

- *Sediment Controls:* Sediment produced by upgrading and constructing roads and removing tailings and waste rock will be controlled by installing BMPs at locations downslope of the road improvements constructed in sensitive areas such as wetlands and stream crossings, and downslope of tailings and waste rock removal areas. Dust created during project construction would be mitigated using BMPs.

- *Road Upgrade and Construction:* Road upgrade work necessary under Alternative 4 would include those required for Alternative 2 as well as constructing two access roads to the Bear Top/Orofino Mill Site and installing/removing a temporary bridge to access tailings south of Bear Gulch Creek (Figure 6). An access road would also be constructed at the central repository site.

  If Alternative No. 4 is implemented, road improvements in addition to those for Alternative 3 would be required including regrading, improving drainage, increasing width, and adding turnouts on

selected portions of FS Road 938 and the 4-wheel drive roads leading to the lower workings of the Orofino Mine and lower and upper workings of the Silver Scott Mine. The travel width of a 4-wheel drive road would be 14 feet once it is improved. A total of 100 feet of access road would be constructed at the central repository site. Travel width of the access road would be 24 feet to allow two-way haul truck traffic.

For Alternative 4, total new disturbance associated with road upgrades and construction is expected to be 0.91 ac.

- *Construct Cell at Central Repository With Geosynthetic Clay Liner (GCL) in Cover:* Design items for repository construction include:

  - Clearing and grubbing the repository cell footprint;
  - Excavating and stockpiling one foot of topsoil from the disturbance area;
  - Excavating subsoil to a depth of four feet within the footprint of the cell;
  - Compacting the subgrade of the cell to a specified density;
  - Placing and compacting the tailings and waste rock in the cell;
  - Grading and shaping the waste to obtain suitable slopes and subgrade for cover construction;
  - Placing the GCL and geomembrane liner;
  - Constructing the soil cover using soil salvaged from the repository site;
  - Constructing runon and runoff control ditches around the perimeter of the cell; and,
  - Applying appropriate fertilizer, seed, and mulch on the completed cover.

The area of the repository cell footprint would cover approximately 3.7 ac.

- *Construct and Remove Surface Water Diversion System:* Temporary surface water diversion will be required to remove saturated tailings and one-foot of saturated native soil from the tailings area. Diversion will involve piping surface water around the excavation area. The diversion pipe length will be about 1,100 feet.

- *Excavate/Load/Haul Waste:* Excavate, load, and haul tailings and waste rock. One-foot of over-excavation will be performed in the tailings removal area, and about 0.5 foot in the waste rock removal areas (lower workings at the Orofino Mine and upper and lower workings at the Silver Scott Mine) for a total of about 23,680 bank cubic yards (bcy). Excavated waste will be loaded onto haul trucks and hauled to the USDS-FS repository.

- *Load/Haul/Place/Compact Backfill:* Backfill would be obtained from a nearby borrow site, if suitable sources of backfill are available locally, or would be obtained from a known source adjacent to the USDS-FS repository. The backfill would be hauled, placed and compacted in the tailings removal area to match surrounding topography. The total volume of backfill required is estimated to be about 12,800 bcy. Backfill would not be placed in the waste rock removal areas.

- *Amend Backfill With Compost:* The backfilled tailings removal area will be amended with compost to a depth of four inches. The total area of backfill to be amended with compost will be about 3.5 ac.

- *Reconstruct Bear Gulch Creek:* Reconstruct the streambed and streambanks of Bear Gulch Creek. The length of stream channel requiring reconstruction totals about 1,000 feet. Reconstruction will consist of placing streambed gravel and constructing fabric-wrapped streambanks. The new stream channel will consist of riffles, runs and pools and approximate its present sinuosity.

- *Prepare Planting Areas and Plant Native Trees and Shrubs On Waste Rock Dumps*: This alternative would follow the same approach for planting native trees and shrubs as described for Alternative 2, excluding the lower workings of the Orofino Mine and the lower and upper workings of the Silver Scott Mine.

- *Install French Drains and Infiltration Basins*: French drains will be installed at the five flowing adits to allow free drainage of water from the adits and infiltration basins will be constructed near the mouth of each flowing adit to minimize surface discharge.

- *Obliterate/Close Access Roads and Trails:* This alternative would follow the same approach for obliterating and closing roads and trails as described for Alternative 2.

- *Fertilize, Seed With Native Species and Mulch Disturbed Areas:* Areas disturbed by construction would be fertilized, seeded and mulched to establish vegetation. Disturbed areas would include obliterated roads, removal areas, and disturbances associated with the central repository.

- *PRSC*: Vegetation established on waste removal, vegetation improvement, disturbed areas, and the central repository would be monitored and maintained.

7.3.4.1 Effectiveness

Disposal of excavated tailings and waste rock in a central repository would be an effective alternative for reducing contaminants at the site. The repository will be constructed in an area centrally located in the Prichard Creek drainage. The first cell of the facility is scheduled for construction in 2003 and will receive waste rock from mine sites located in Paragon Gulch. The Bear Gulch Mine Complex wastes would be placed in a second cell at the USDS-FS repository. Tailings deposited along Bear Gulch Creek at the Bear Top/Orofino Mill Site, and accessible waste rock at the Lower Orofino Workings and Upper and Lower Silver Scott Workings would be removed. No action would be taken on tailings deposited downstream of the removal area along Bear Gulch Creek. As with Alternatives 2 and 3, this alternative would improve slope stability and would reduce erosion of waste rock.

❖ *OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT*

Alternative 4 reduces risk to human health and the environment by removing tailings and three waste rock dumps, and limiting access to the remaining waste dumps. Alternative 4 reduces the potential for further erosion and migration of contaminants from exposed waste rock dumps located in Bear Gulch by stabilizing them with vegetation. Under this alternative, 41% of the volume of waste present in the Complex is removed, and exposure to humans and the environment are controlled by covering with soil in an engineered facility. In addition, 80% of the area of exposed waste is reclaimed, eliminating a substantial portion of the direct exposure and ingestion risk from mine wastes in the Complex.

As with Alternative 3, Alternative 4 substantially reduces risk to human health and the environment in the tailings removal area and eliminates the potential for further erosion and migration of contaminants from the tailings source area located immediately adjacent to Bear Gulch Creek. Residual risk at the

inaccessible waste rock dumps is reduced to an area of about one acre, and exposure to lead in these wastes is further reduced to humans by closing roads and trails that lead to these wastes.

As with Alternatives 2 and 3, Alternative 4 limits exposure to adit discharges through efforts to eliminate surface discharge and by limiting access to the dumps where adits are located. By closing adits and stopes, physical safety hazards would be eliminated.

Project objectives would be substantially met under this alternative. Safety hazards would be eliminated and human health hazards would be reduced. Hazards presented by sediment and metals contamination to Bear Gulch Creek would be reduced, which would improve aquatic health and habitat.

❖ *COMPLIANCE WITH ARARS*

Compliance with contaminant-specific ARARs should be achieved for any discharges released to surface water after removals are complete. Removing the tailings is not expected to result in full compliance with contaminant-specific ARARs in Bear Gulch because other sources of metals will remain in place downstream of the tailings. However, it is expected that removal of tailings will improve surface water quality at and downstream of the Complex.

Because groundwater has not been investigated, it is not known whether groundwater quality is impacted. Removal of tailings and waste rock, however, should not degrade groundwater quality and will likely provide a positive effect and improve groundwater quality beneath the removal areas. Groundwater quality will not be changed from current conditions in the waste rock areas where removals will not be done.

Contaminant-specific ARARs for ambient air are expected to be met under this alternative because the wastes will be covered in a repository and the repository and removal areas revegetated. Dust generated during construction will be managed using BMPs.

Location-specific ARARs at the tailings and waste rock dump removal sites are expected to be met to a substantial degree. There are no known historic or archaeological resources in the vicinity of the removal areas or the proposed repository site.

No sensitive or rare plants are known to exist in the project area that would be disturbed by implementing this alternative. Threatened and endangered species present in the vicinity of the project include bull trout, Canada lynx, and bald eagle, although no critical habitat has been designated or proposed for threatened and endangered species in the project area. Road improvements associated with this alternative include installing a temporary bridge over Bear Gulch Creek and widening FS Road 938. Any impacts to bull trout from road improvements will be mitigated using BMPs during construction. Impacts to bull trout from removal and reconstruction of 1,000 feet of Bear Gulch Creek will be mitigated through BMPs, including limiting the stream removal and construction work to avoid spawning periods. Construction and reclamation activities at the removal areas and repository will be completed in a relatively short period of time, limiting impacts to Canada lynx and bald eagle. Maintenance of permanent facilities (the repository cell) will not require a level of activity that is greater than that existing under current conditions.

Other location-specific ARARs at the waste rock dump removal sites will be protected through substantive compliance with the requirements of laws related to streambeds, floodplains, and wetlands. The Floodplain and Floodway Management Act will be complied with because no response activities will be conducted in a designated 100-year floodplain. Streambanks and the stream channel in the tailings

removal area will be reconstructed with earth and natural materials and sufficiently protected with erosion control techniques so that the bed and banks are protected from flood erosion. All disturbed areas will be managed during construction to minimize erosion. Location-specific ARARs derived from the Idaho Solid Waste Management Act and regulations will be complied with at the repository site.

Action-specific ARARs are expected to be met by this alternative. Action-specific ARARs for storm water runoff will be complied with through the use of BMPs at the removal areas and at the repository. No facilities require a discharge of waste to the environment. Substantive requirements of the Idaho Solid Waste Management Act will be met at the repository site through design criteria. Because mine wastes are derived from the beneficiation and extraction of ores, tailings generally are exempt from federal and state regulation under RCRA as a hazardous waste (42 U.S.C. 6921 (b) (3) (A)(iii)(1994).

Revegetation requirements contained in the Surface Mining Control and Reclamation Act would be substantively met at the removal and repository sites by using primarily native species and matching species to surrounding habitat types. BMPs for seeding, planting, mulching, soil amendments, control of noxious weeds, and erosion control will also be followed under this alternative. Other requirements for treating surface drainage, sediment control, construction and maintenance of sedimentation ponds, discharges from sedimentation ponds, and provisions for groundwater will be met by using BATs.

Action-specific State of Idaho air quality regulations related to dust suppression and control during construction activities will be met using BMPs.

Occupational Safety and Health Administration requirements would be met by requiring appropriate safety training for all on-site workers during construction phase. Site activities would be conducted under the guidance of a Health and Safety Plan for the site per OSHA 29 CFR 1910.120. Site personnel will have completed 40-hour hazardous waste operations and emergency response training and would be current with the 8-hour annual refresher training as required by OSHA 29 CFR 1910.120.

❖ *LONG-TERM EFFECTIVENESS AND PERMANENCE*

This alternative is expected to be effective in the long-term and permanent because the majority of tailings and accessible waste rock will be removed from the site. Waste rock not removed as part of this alternative constitutes about 59% of the estimated total waste volume at the site; this waste will remain in the existing condition and long-term maintenance of it may be required.

Once vegetation is established and maintained for several years at the cell in the central repository, tailings removal area, and waste rock dumps, it should persist over the long-term, although the effectiveness of vegetation in reducing erosion will be difficult to determine. Roads that have been closed by obliteration and revegetation will be effective in the long-term and permanent. Roads closed using man-made structures will only remain effective as long as those structures are maintained.

PRSC involving monitoring and maintenance will be conducted at the removal area, central repository, and vegetation improvement areas. Monitoring and maintenance will improve the chances for achieving long-term effectiveness.

❖ *REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT*

There will be some reduction in mobility but no reduction of toxicity or volume through treatment with this alternative. Mobility of contaminants will be essentially eliminated with regard to tailings and waste

rock removed as part of this alternative. Mobility of the remaining waste rock will be reduced to some extent through vegetative treatments.

❖ *SHORT-TERM EFFECTIVENESS*

Alternative 4 should be completed in a single construction season of not more than 90 days. Therefore, impacts associated with construction activities are considered short-term, and should not significantly impact human health. On-site workers will be protected by following a site specific Health and Safety Plan, employing appropriate personal protective equipment and by following proper operating and safety procedures.

The major short-term impact to the surrounding area and wildlife involves increased vehicle traffic and temporary closures of some forest roads. An increase in traffic will occur during mobilization and demobilization of construction equipment, and during transport of waste to the central repository, construction of the repository, and transport of materials for backfill. An estimated 22 pieces of construction equipment will be mobilized to the site to implement this removal action. Equipment will include bulldozers (3), excavators (3), backhoes (1), haul trucks (8), transports (2), and miscellaneous light duty trucks (5). Materials will be supplied by transports and trucks that will periodically travel to the site. An estimate of one truck or transport trip per day is anticipated for the construction season. Increased traffic may impact wildlife by either changing daily migration patterns or exposing wildlife to a higher potential for injury or death due to collisions with vehicles.

Short-term road closures in the project area may be necessary, limiting access to the forest. To haul the estimated 20,500 cy of tailings (adjusted for 20% swell) and 7,900 cy of waste rock to the central repository, about 1,900 round-trip truck trips (using belly dump haul trucks with trailers) will be made on Forest Highway 9, and FS Road Nos. 152 and 938. The same trucks will be used to backhaul the estimated 15,400 cy of backfill to the site from the borrow area. Assuming 30-ton transport trucks could be used to deliver the estimated 315 tons of compost for backfill amendment at the tailings removal area, about 11 truck trips will be made between the compost source and the Complex.

Short-term air quality impacts to the immediate environment may occur during excavation, hauling, and placement of wastes, backfill and compost incorporation. Dust control on designated haul routes is an expected requirement and control of fugitive dusts will utilize BMPs.

Road improvements needed to implement this alternative may have some short-term impacts on the watershed. Increased sedimentation may result from road improvements due to an increased sediment load from exposed widened roads and deeper and wider borrow ditches. These impacts will be mitigated by implementing BMPs for stormwater runoff.

7.3.4.2 Implementability

Total removal of tailings and three waste rock dumps to a central repository is both technically and administratively feasible. Key project components such as equipment, materials, and construction expertise are available. Availability will allow the timely implementation and successful execution of the alternative.

7.3.4.3 Cost

The detailed cost analysis for Alternative 4 is included in Appendix B. The total estimated cost for this alternative is about $2.47 million. Closure of mine openings account for 5% of the total estimated cost

and repository construction costs account for about 25% of the total estimated cost. Waste removal costs account for about 24% of the total estimated cost. A haul cost of $14.70 per cubic yard waste was estimated. Backfill hauling and placement costs account for about 10% of the total estimated cost. For cost estimating purposes, it was assumed that backfill would be obtained from an area adjacent to the USDS-FS repository, about 12 miles by road from the consolidation site. If a more local source of backfill can be found, haul costs associated with this item could be reduced considerably. A back-haul cost of $9.90 per cubic yard backfill was estimated. Bear Gulch Creek reconstruction costs account for 2% of the total estimated cost. PRSC costs associated with maintenance of this alternative total $68,000 in present worth.

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8.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section compares the four alternatives presented in Section 7.0. The comparative analysis is performed for each of the three primary criteria: effectiveness, implementability, and cost.

8.1 EFFECTIVENESS

Alternative 4, removal of tailings and a portion of the identified waste rock to a central repository, is the most effective alternative evaluated. Under this alternative, 41% of the volume of waste present in the Complex is removed, and exposure to humans and the environment are controlled by covering with soil in an engineered facility. In addition, 80% of the area of exposed waste is reclaimed, eliminating a substantial portion of the direct exposure and ingestion risk from mine wastes in the Complex. Residual risk at the inaccessible waste rock dumps is reduced to an area of about one acre, and exposure to lead in these wastes is further reduced to humans by closing roads and trails that lead to these wastes.

Alternative 3, consolidation of tailings outside of the 100-year floodplain is less effective than Alternative 4 because three waste rock dumps would not be removed. However, 67% of the area covered by COCs in the Complex (about 3.2 acres) is reclaimed, and tailings, mixed tailings, and concentrates that contain the highest concentrations of COCs are covered, preventing direct contact and ingestion pathways to humans and wildlife. Residual risk from lead remains at the waste rock dumps, but exposure to lead in these wastes is reduced to humans by closing roads and trails that lead to these wastes.

Alternative 2, which improves vegetation on waste rock dumps in order to promote slope stability and reduce downslope movement of the wastes, is the least effective of the alternatives evaluated because these wastes are not removed, covered, or treated. Therefore, reductions in exposure of humans to lead in these wastes is fully dependent on closure of roads and trails, and only minor reductions in metal mobility can be realized. Exposure of COCs in the wastes to wildlife is essentially the same as current conditions under this alternative.

Safety risks would be decreased by all the alternatives except No Action through closure of open adits and stopes, and closure of all roads and trails accessing the waste dumps. Residual risk remains from metals released by adit discharges under all the alternatives.

Alternative 2 has the least short-term impacts to the area because it can be constructed in the shortest time with the least amount of equipment, and confines nearly all the impacts that result from removal action construction to within the Complex. Alternative 2 requires only minimal road upgrades compared to the road upgrades needed to implement Alternatives 3 and 4, and requires much less travel on local highways. Short-term impacts associated with Alternative 4 places the most impacts on local roads as a large number of truck trips would be made to haul waste to the USDS-FS repository, and an equally large number of trips required to haul backfill needed to reconstruct the tailings removal area. Short-term impacts associated with Alternative 3 are about the same as Alternative 4, as backfill would still be hauled from either a nearby local source of backfill or the USDS-FS repository to Bear Gulch, but these impacts would occur over a shorter period of time. As a result, Alternative 4 poses the greatest risk to people and wildlife from potential vehicular accidents.

Alternatives 3 and 4 are the most likely of the three alternatives evaluated to comply with ARARs, including contaminant-specific numeric standards. Alternatives 3 and 4 may also comply with action-specific ARARs because a majority of the wastes adjacent to the flowing surface water in Bear Gulch will

be removed. Alternative 2 will not meet these same ARARs because only a portion of the wastes (waste rock) present will be stabilized, leaving the tailings untreated. Although adit discharges do not currently meet water quality criteria, the relatively low flows are not believed to affect water quality in Bear Gulch Creek, and all three alternatives will minimize flows at the surface, thus reducing risks of exposure of the discharges to humans and wildlife.

8.2 IMPLEMENTABILITY

All alternatives are technically and administratively feasible. Essential project components such as equipment, materials, and construction expertise are available. However, under all three alternatives, improving vegetation on waste rock dumps may be difficult on steeper and less roaded areas of the Complex (e.g. Upper Orofino and Upper Ione Mines) and difficulties with implementability may be encountered. Construction elements associated with Alternatives 3 and 4 may also be difficult to implement, especially associated with removal of tailings and diversion of surface water flow in Bear Gulch around the tailings removal and stream reconstruction area.

8.3 COST

Alternative No. 4, removal of tailings and accessible waste rock to a central repository is the most expensive of the evaluated alternatives. The total cost to implement this alternative is about $2.5 million. This cost is about $0.93 million higher, or two-thirds more, than Alternative 3 (estimated cost of $1.54 million). The estimated cost for Alternative 2 is $410,000, and the cost for no action is about $2,500 annually for monitoring, which equates to a present-worth cost for 30 years of $47,000.

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APPENDIX A

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)

Bear Gulch Mine Complex

Preliminary Identification of Applicable or Relevant and Appropriate Requirements
Bear Gulch Mine Complex
USDA Forest Service – Northern Region

Standard, Requirement Criteria Or Limitation	Citation	Description	ARAR Status
FEDERAL CONTAMINANT-SPECIFIC			
Safe Drinking Water Act National Primary Drinking Water Regulation	40 USC § 300 40 CFR Part 141	Establishes health-based standards (MCLs) for public water systems.	Relevant and Appropriate
National Secondary Drinking Water Regulations	40 CFR Part 143	Establishes welfare-based standards (secondary MCLs) for public water systems.	Relevant and Appropriate
Clean Water Act Water Quality Standards	33 USC. §§ 1251-1387 40 CFR Part 131 Quality Criteria for Water 1976, 1980, 1986	Ch. 26- Water Pollution Prevention & Control Sets criteria for water quality based on toxicity to aquatic organisms and human health.	Relevant and Appropriate
FEDERAL LOCATION-SPECIFIC			
National Historic Preservation Act	16 USC § 470; 36 CFR Part 800; 40 CFR Part 6.310(b)	Requires Federal Agencies to take into account the effect of any Federally-assisted undertaking or licensing on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register of Historic Places and to minimize harm to any National Historic Landmark adversely or directly affected by an undertaking.	Not Applicable – no historic places or landmarks
Archaeological and Historic Preservation Act	16 USC § 469; 40 CFR ' 6.301(c)	Establishes procedures to provide for preservation of historical and archaeological data which might be destroyed through alteration of terrain as a result of a Federal construction project or a Federally licensed activity or program.	Applicable
Historic Sites, Buildings and Antiquities Act	36 CFR § 62.6(d)	Requires Federal agencies to consider the existence and location of landmarks on the National Registry of Natural Landmarks to avoid undesirable impacts on such landmarks.	Not Applicable – no historic buildings
Protection of Wetlands Order	40 CFR Part 6	Avoid adverse impacts to wetlands.	Applicable

Preliminary Identification of Applicable or Relevant and Appropriate Requirements Bear Gulch Mine Complex USDA Forest Service – Northern Region			
Standard, Requirement Criteria Or Limitation	**Citation**	**Description**	**ARAR Status**
Migratory Bird Treaty Act	16 USC § 703 et seq.	Establishes a federal responsibility for the protection of international migratory bird resource.	Applicable
FEDERAL LOCATION-SPECIFIC (continued)			
Fish and Wildlife Coordination Act	16 USC § 661 et seq.; 40 CFR Part 6.302(g)	Requires consultation when Federal department or agency proposes or authorizes any modification of any stream or other water body and adequate provision for protection of fish and wildlife resources.	Applicable
Floodplain Management Order	40 CFR Part 6	Requires Federal agencies to evaluate the potential effects of actions they may take in a floodplain to avoid the adverse impacts associated with direct and indirect development of a floodplain, to the extent possible.	Relevant and Appropriate
Bald Eagle Protection Act	16 USC §§ 668 et seq.	Establishes a federal responsibility for protection of bald and golden eagles. Requires consultation with the USFWS.	Applicable
Endangered Species Act	16 USC §§ 1531-1543; 40 CFR Part 6.302(h); 50 CFR Part 402	Requires action to conserve endangered species within the ecosystem upon which species depend. Includes consultation with Dept. of Interior.	Applicable
FEDERAL ACTION-SPECIFIC			
Clean Water Act National Pollutant Discharge Elimination System	33 USC §§ 1251-1387 40 CFR Parts 121, 122, 125	Requires permits for the discharge of pollutants from any point source into waters of the United States.	Relevant and Appropriate
Clean Air Act National Primary and Secondary Ambient Air Quality Standards	42 USC § 7409;40 CFR Part 50.12	Air quality levels that protect public health.	Applicable
Surface Mining Control and Reclamation Act	30 CFR Parts 816, 784	Reclamation requirements for coal and certain non-coal mining.	Relevant and Appropriate

Preliminary Identification of Applicable or Relevant and Appropriate Requirements
Bear Gulch Mine Complex
USDA Forest Service – Northern Region

Standard, Requirement Criteria Or Limitation	Citation	Description	ARAR Status
Resource Conservation and Recovery Act	42 USC § 6901	Defines solid wastes that are subject to regulation as hazardous wastes under 40 CFR Parts 262-265 and Parts 124, 270 and 271.	
	40 CFR Part 257.3	Governs waste handling and disposal	Applicable
	40 CFR Part 264.228	Provisions regarding run-on and run-off controls	Applicable
	40 CFR 264.300 et seq.	Strategies for preventing releases from consolidation areas (e.g. controlling run-on and run-off)	Relevant and Appropriate
FEDERAL ACTION-SPECIFIC (continued)			
Occupational Safety And Health Act Hazardous Waste Operations And Emergency Response	29 USC § 655 29 CFR 1910.120	Defines standards for employee protection during initial site characterization and analysis, monitoring activities, materials handling activities, training & ER.	Applicable
STATE CONTAMINANT-SPECIFIC			
Groundwater Quality Standards	IDAPA 58.01.11, 200	Primary and secondary constituent numerical standards for groundwater, based on protection of human health	Applicable
Surface Water Quality Standards	IDAPA 58.01.02, 100-101; 200; 210; 250; 251; 253.	Designates uses that are to be protected in and of the waters of the State and establishes standards of water quality protective of those uses.	Applicable
Air Quality Standards	IDAPA 58.01.01	Rules governing the control of air pollution in Idaho. Emission of air contaminants that are toxic to human health and animal life vegetation. Emissions of air contaminants that occur during response activities will not be in a quantity or concentration that injure or unreasonably affect human health, animal life, or vegetation.	Applicable
STATE LOCATION-SPECIFIC			
Hazardous Waste Management Act of 1983	I.C 39-4401 et seq.	Legislation governing the disposal and management of hazardous waste in Idaho through adoption of Federal RCRA regulations.	Relevant and Appropriate

Preliminary Identification of Applicable or Relevant and Appropriate Requirements Bear Gulch Mine Complex USDA Forest Service – Northern Region			
Standard, Requirement Criteria Or Limitation	**Citation**	**Description**	**ARAR Status**
Rules and Standards for Hazardous Waste	IDAPA 58.01.05	Adopts by reference CFR, Title 40, Parts 124, 260-266, 268, 270, 273, and 279. Defines hazardous wastes and rules governing disposal and management of waste.	Relevant and Appropriate
STATE LOCATION-SPECIFIC (continued)			
Preservation of Historic Sites	I.C. Section 67-4601 to 4619	Authorizes local governing bodies to engage in a comprehensive program of historical preservation.	Not Applicable - no historic places or landmarks
STATE ACTION-SPECIFIC			
Solid Waste Management Rules and Standards	IDAPA 58.01.06, 005	Establishes requirements applicable to solid waste management.	Relevant and Appropriate

APPENDIX B

ESTIMATED REMOVAL ACTION COSTS

Bear Gulch Mine Complex

Cost Analysis

Project: Bear Gulch Mine Complex

Client: USDA Forest Service, Region 1

Description: Alternative Cost Summary

Alternative	Description	Est. Cost
1	No Action (Assumes only surface water monitoring at two locations on an annual basis for 30 years)	$46,667
2	Improve Vegetation on, and Limit Access to, Waste Rock Dumps	$407,800
3	Consolidate Tailings Out of the 100-Year Floodplain; Improve Vegetation on, and Limit Access to, Waste Rock Dumps	$1,542,300
4	Remove Tailings and Accessible Waste Rock Dumps to a Central Repository; Improve Vegetation on, and Limit Access to, Waste Rock Dumps	$2,474,800

Cost Analysis

Project: Bear Gulch Mine Complex

Client: USDA Forest Service, Region 1

Description: Close Mine Openings for Alternatives 2, 3 and 4

ITEM	UNIT	COST	QUANTITY	EXTENDED COST
CLOSE OPEN ADITS and STOPES				
Close Open Adit Using Bat Grate	ea	$2,800.00	12	$33,600
Close Small Stope Using Poly Foam	cy	$75.00	250	$18,750
Close Large Stope Using Poly Foam	cy	$65.00	1000	$65,000
			Subtotal:	**$117,350**
			ESTIMATED COST:	**$117,350**

Cost Analysis

Project: Bear Gulch Mine Complex

Client: USDA Forest Service, Region 1

Description: Alternative 2 - Improve Vegetation on, and Limit Access to, Waste Rock Dumps

ITEM	UNIT	COST	QUANTITY	EXTENDED COST
CLOSE OPEN ADITS and STOPES	ls	117,350.00	1	$117,350
			Subtotal:	**$117,350**
PROTECT HISTORIC FEATURES				
Structures	ea	$500.00	2	$1,000
			Subtotal:	**$1,000**
GENERAL				
Clearing and Grubbing	ac	$1,875.00	5.1	$9,563
			Subtotal:	**$9,563**
ROAD UPGRADES				
Minor Upgrades to FS Roads	mi	$2,000.00	4.00	$8,000
Major Upgrades to FS Roads	mi	$6,500.00	2.50	$16,250
			Subtotal:	**$24,250**
ROAD CONSTRUCTION				
Bridge Removal and Culvert Installation (72X55 inch arch pipe)	ft	$181.25	40.00	$7,250
Road Closure - Typical USFS Lockable Gate	ea	$1,400.00	2	$2,800
			Subtotal:	**$10,050**
SEDIMENT CONTROL				
Install/Remove Silt Fence	ft	$1.04	200	$207
Install/Remove Straw Bales	ft	$3.99	100	$399
			Subtotal:	**$606**
ADIT DISCHARGE				
French Drain	ea	$1,000.00	5	$5,000
Adit Discharge Infiltration Basin	ea	$4,000.00	5	$20,000
			Subtotal:	**$25,000**
RECLAMATION OF DISTURBED AREAS				
Road obliteration	mi.	$2,000.00	2.50	$5,000
Fertilize, Seed and Mulch	ac	$4,000.00	5.10	$20,400
Prepare Planting Areas and Plant Native Trees and Shrubs on Waste Rock Dumps	ea	$70.00	550	$38,500
			Subtotal:	**$63,900**
			SUBTOTAL	**$251,719**
			Mobilization, Bonding, and Insurance (12.5%)	$31,500
			Contingency (10%)	$25,200
			Total Construction Estimate	**$308,500**
			Engineering Evaluation and Design (10%)	$30,900
			Construction Oversight (5%)	$15,500
			Present Worth Post-Removal Site Control Estimate	$52,852
			TOTAL ESTIMATED COST	**$407,800**

Post-Removal Site Control (PRSC) Costs for Alternative 2 Bear Gulch Mine Complex					
Year	Excavation and Earth Work $/year	Fertilizer Reapplication $/year	Seed Reapplication $/year	Surface Water Monitoring $/year	TOTAL COST $/year
1	$2,500	$500	$1,500	$2,500	$7,000
2	$500	$500	$1,500	$2,500	$5,000
3	$500	$500	$1,500	$2,500	$5,000
4	$250		$500	$2,500	$3,250
5	$250	$500	$500	$2,500	$3,750
6	$250			$2,500	$2,750
7	$250			$2,500	$2,750
8	$250			$2,500	$2,750
9	$250			$2,500	$2,750
10	$250			$2,500	$2,750
11				$2,500	$2,500
12				$2,500	$2,500
13				$2,500	$2,500
14				$2,500	$2,500
15				$3,000	$3,000
16				$3,000	$3,000
17				$3,000	$3,000
18				$3,000	$3,000
19				$3,000	$3,000
20				$3,000	$3,000
21				$3,000	$3,000
22				$3,000	$3,000
23				$3,000	$3,000
24				$3,000	$3,000
25				$3,000	$3,000
26				$3,000	$3,000
27				$3,000	$3,000
28				$3,000	$3,000
29				$3,000	$3,000
30				$3,000	$3,000
		Total			$95,750
				Net Present Value (Discount Rate = 4.9%)	$52,852

Cost Analysis

Project: Bear Gulch Mine Complex

Client: USDA Forest Service, Region 1

Description: Alternative 3 - Consolidate Tailings Out of the 100-Year Floodplain; Improve Vegetation on, and Limit Access to, Waste Rock Dumps

ITEM	UNIT	COST	QUANTITY	EXTENDED COST
CLOSE OPEN ADITS and STOPES	ls	117,350.00	1	$117,350
			subtotal:	**$117,350**
PROTECT HISTORIC FEATURES				
Structures	ea	$500.00	4	$2,000
			subtotal:	**$2,000**
GENERAL				
Clearing and Grubbing	ac	$1,875.00	10.2	$19,125
Remove and Dispose of Debris	ton	$250.00	4	$1,000
			subtotal:	**$20,125**
ROAD UPGRADES				
Minor Upgrades to FS Roads	mi	$2,000.00	4.00	$8,000
Major Upgrades to FS Roads	mi	$6,500.00	2.50	$16,250
			subtotal:	**$24,250**
ROAD CONSTRUCTION				
Bridge Removal and Culvert Installation (72X55 inch arch pipe)	ft	$181.25	40.00	$7,250
Road Closure - Typical USFS Lockable Gate	ea	$1,400.00	2	$2,800
Topsoil Stripping and Stockpiling	cy	$1.60	125	$200
Dozer Excavation/Motor Grading	mi	$3,584.00	0.04	$143
Culvert Removal/Installation (24 inch pipe)	ft	$30.00	40	$1,200
Temporary Bridge Installation/Removal (Contractor Furnished)	ls	$12,500.00	1	$12,500
			subtotal:	**$24,093**
SEDIMENT CONTROL				
Install/Remove Silt Fence	ft	$1.04	900	$931.50
Install/Remove Straw Bales	ft	$3.99	450	$1,795.50
			subtotal:	**$2,727**
CONSOLIDATION SITE CONSTRUCTION				
Topsoil Stripping and Stockpiling	cy	$1.60	2,260	$3,616
Excavate Subsoil in Footprint	cy	$2.20	9,034	$19,875
Compact Subgrade	cy	$0.78	1,130	$881
Place and Compact Waste	cy	$2.94	17,080	$50,215
Grade and Shape Waste	cy	$5.90	17,080	$100,772
Replace Subsoil and Topsoil	cy	$8.75	11,294	$98,823
Construct Runon and Runoff Control Ditches	ft	$5.28	100	$528
Erosion Control Blanket	ac	$4,840.00	1.4	$6,776
			subtotal:	**$281,486**
SURFACE WATER DIVERSION				
Install Diversion Berm	ls	$3,500.00	1	$3,500
Install Diversion Pipe (24" dia. SDR 21 HDPE)	ft	$43.00	1,100	$47,300
Construct Sediment Basin Berm	ea	$3,000.00	1	$3,000
			subtotal:	**$53,800**
WASTE REMOVAL				
Excavate, Load and Haul Tailings to Consolidation Site	cy	$5.30	20,496	$108,629
			subtotal:	**$108,629**
BACKFILL PLACEMENT				
Load, Haul, Place and Compact with full trip	cy	$20.19	15,360	$310,118
			subtotal:	**$310,118**
PRODUCE TOPSOIL				
Amend Backfill With Compost	ac	$4,975.00	3.5	$17,413
			subtotal:	**$17,413**
STREAM RECONSTRUCTION - BEAR GULCH				
Rebuild Streambanks and Streambed	ft	$45.00	1,000	$45,000
			subtotal:	**$45,000**

Cost Analysis

Project: Bear Gulch Mine Complex

Client: USDA Forest Service, Region 1

Description: Alternative 3 - Consolidate Tailings Out of the 100-Year Floodplain; Improve Vegetation on, and Limit Access to, Waste Rock Dumps

ITEM	UNIT	COST	QUANTITY	EXTENDED COST
ADIT DISCHARGE				
French Drain	ea	$1,000.00	5	$5,000
Adit Discharge Infiltration Basin	ea	$4,000.00	5	$20,000
			Subtotal:	**$25,000**
RECLAMATION OF DISTURBED AREAS				
Road obliteration	mi.	$2,000.00	2.50	$5,000
Fertilize, Seed and Mulch	ac	$4,000.00	10.2	$40,800
Prepare Planting Areas and Plant Native Trees and Shrubs on Waste Rock Dumps	ea	$70.00	400	$28,000
Revegetate Streambanks	ft	$10.00	1,000	$10,000
			subtotal:	**$83,800**
			SUBTOTAL	**$1,115,800**
			Mobilization, Bonding, and Insurance (12.5%)	$139,500
			Contingency (10%)	$111,600
			Total Construction Estimate	**$1,366,900**
			Engineering Evaluation and Design (5%)	$68,400
			Construction Oversight (3%)	$41,100
			Present Worth Post-Removal Site Control Estimate	$65,801
			TOTAL ESTIMATED COST	**$1,542,300**

Post-Removal Site Control (PRSC) Costs for Alternative 3 Bear Gulch Mine Complex					
Year	Excavation and Earth Work $/year	Fertilizer Reapplication $/year	Seed Reapplication $/year	Surface Water Monitoring $/year	TOTAL COST $/year
1	$5,000	$1,000	$2,500	$2,500	$11,000
2	$2,500	$1,000	$2,000	$2,500	$8,000
3	$2,500	$1,000	$1,000	$2,500	$7,000
4	$1,000		$1,000	$2,500	$4,500
5	$1,000	$1,000	$1,000	$2,500	$5,500
6	$500			$2,500	$3,000
7	$500			$2,500	$3,000
8	$500			$2,500	$3,000
9	$500			$2,500	$3,000
10	$500			$2,500	$3,000
11				$2,500	$2,500
12				$2,500	$2,500
13				$2,500	$2,500
14				$2,500	$2,500
15	$1,000			$3,000	$4,000
16				$3,000	$3,000
17				$3,000	$3,000
18				$3,000	$3,000
19				$3,000	$3,000
20	$1,000			$3,000	$4,000
21				$3,000	$3,000
22				$3,000	$3,000
23				$3,000	$3,000
24				$3,000	$3,000
25	$1,000			$3,000	$4,000
26				$3,000	$3,000
27				$3,000	$3,000
28				$3,000	$3,000
29				$3,000	$3,000
30	$1,000			$3,000	$4,000
		Total			$113,000
			Net Present Value (Discount Rate = 4.9%)		$65,801

Cost Analysis

Project: Bear Gulch Mine Complex

Client: USDA Forest Service, Region 1

Description: Alternative 4 - Remove Tailings and Accessible Waste Rock to a Central Repository; Improve Vegetation on, and Limit Access to, Waste Rock Dumps

ITEM	UNIT	COST	QUANTITY	EXTENDED COST
CLOSE OPEN ADITS and STOPES	ls	117,350.00	1	$117,350
			subtotal:	**$117,350**
PROTECT HISTORIC FEATURES				
Structures	ea	$500.00	6	$3,000
			subtotal:	**$3,000**
GENERAL				
Clearing and Grubbing	ac	$1,875.00	10.2	$19,125
Remove and Dispose of Debris	ton	$250.00	6	$1,500
			subtotal:	**$20,625**
ROAD UPGRADES				
Minor Upgrades to FS Roads	mi	$2,000.00	4.00	$8,000
Major Upgrades to FS Roads	mi	$6,500.00	2.50	$16,250
			subtotal:	**$24,250**
ROAD CONSTRUCTION				
Bridge Removal and Culvert Installation (72X55 inch arch pipe)	ft	$181.25	40.00	$7,250
Road Closure - Typical USFS Lockable Gate	ea	$1,400.00	2	$2,800
Topsoil Stripping and Stockpiling	cy	$1.60	90	$144
Dozer Excavation/Motor Grading	mi	$3,584.00	0.03	$108
Culvert Removal/Installation (24 inch pipe)	ft	$30.00	32	$960
Temporary Bridge Installation/Removal (Government Furnished)	ls	$12,500.00	1	$12,500
			subtotal:	**$13,712**
SEDIMENT CONTROL				
Install/Remove Silt Fence	ft	$1.04	900	$932
Install/Remove Straw Bales	ft	$3.99	450	$1,796
			subtotal:	**$2,727**
REPOSITORY CONSTRUCTION				
Topsoil Stripping and Stockpiling	cy	$1.60	5,970	$9,552
Excavate Subsoil in Footprint	cy	$2.20	10,745	$23,639
Compact Subgrade	cy	$0.78	2,985	$2,328
Place and Compact Tailings	cy	$2.94	23,680	$69,619
Grade and Shape Tailings	cy	$5.90	23,680	$139,712
Geosynthetic Clay Liner	sy	$5.40	22,400.0	$120,960
Geomembrane	sy	$5.40	22,400.0	$120,960
Replace Subsoil and Topsoil	cy	$8.75	10,745	$94,019
Construct Runon and Runoff Control Ditches	ft	$5.28	800	$4,224
Erosion Control Blanket	ac	$4,840.00	3.7	$17,908
			subtotal:	**$602,922**
SURFACE WATER DIVERSION				
Install Diversion Berm	ls	$3,500.00	1	$3,500
Install Diversion Pipe (24" dia. SDR 21 HDPE)	ft	$43.00	1,100	$47,300
Construct Sediment Basin Berm	ea	$3,000.00	1	$3,000
			subtotal:	**$53,800**
WASTE REMOVAL				
Excavate, Load and Haul Tailings/Waste Rock to Central Repository	cy	$20.19	28,416	$573,719
			subtotal:	**$573,719**
BACKFILL PLACEMENT				
Load, Haul, Place and Compact with half trip	cy	$15.34	15,360	$235,622
			subtotal:	**$235,622**
PRODUCE TOPSOIL				
Amend Backfill With Compost	ac	$4,975.00	3.5	$17,413
			subtotal:	**$17,413**
STREAM RECONSTRUCTION - BEAR GULCH				
Rebuild Streambanks and Streambed	ft	$45.00	1,000	$45,000
			subtotal:	**$45,000**

Cost Analysis

Project: Bear Gulch Mine Complex

Client: USDA Forest Service, Region 1

Description: Alternative 4 - Remove Tailings and Accessible Waste Rock to a Central Repository; Improve Vegetation on, and Limit Access to, Waste Rock Dumps

ITEM	UNIT	COST	QUANTITY	EXTENDED COST
ADIT DISCHARGE				
French Drain	ea	$1,000.00	5	$5,000
Adit Discharge Infiltration Basin	ea	$4,000.00	5	$20,000
			Subtotal:	**$25,000**
RECLAMATION OF DISTURBED AREAS				
Road obliteration	mi.	$2,000.00	2.50	$5,000
Fertilize, Seed and Mulch	ac	$4,000.00	10.2	$40,800
Prepare Planting Areas and Plant Native Trees and Shrubs on Waste Rock Dumps	ea	$70.00	400	$28,000
Revegetate Streambanks	ft	$10.00	1,000	$10,000
			subtotal:	**$83,800**
			SUBTOTAL	**$1,819,000**
			Mobilization, Bonding, and Insurance (12.5%)	$227,400
			Contingency (10%)	$181,900
			Total Construction Estimate	**$2,228,300**
			Engineering Evaluation and Design (5%)	$111,500
			Construction Oversight (3%)	$66,900
			Present Worth Post-Removal Site Control Estimate	$68,073
			TOTAL ESTIMATED COST	**$2,474,800**

Post-Removal Site Control (PRSC) Costs for Alternative 4 Bear Gulch Mine Complex					
Year	Excavation and Earth Work $/year	Fertilizer Reapplication $/year	Seed Reapplication $/year	Surface Water Monitoring $/year	TOTAL COST $/year
1	$5,000	$1,000	$2,500	$2,500	$11,000
2	$5,000	$1,000	$2,000	$2,500	$10,500
3	$2,500	$1,000	$1,000	$2,500	$7,000
4	$1,000		$1,000	$2,500	$4,500
5	$1,000	$1,000	$1,000	$2,500	$5,500
6	$500			$2,500	$3,000
7	$500			$2,500	$3,000
8	$500			$2,500	$3,000
9	$500			$2,500	$3,000
10	$500			$2,500	$3,000
11				$2,500	$2,500
12				$2,500	$2,500
13				$2,500	$2,500
14				$2,500	$2,500
15	$1,000			$3,000	$4,000
16				$3,000	$3,000
17				$3,000	$3,000
18				$3,000	$3,000
19				$3,000	$3,000
20	$1,000			$3,000	$4,000
21				$3,000	$3,000
22				$3,000	$3,000
23				$3,000	$3,000
24				$3,000	$3,000
25	$1,000			$3,000	$4,000
26				$3,000	$3,000
27				$3,000	$3,000
28				$3,000	$3,000
29				$3,000	$3,000
30	$1,000			$3,000	$4,000
		Total			$115,500
			Net Present Value (Discount Rate = 4.9%)		$68,073

SUMMARY OF ITEM UNIT COSTS FOR REMOVAL COST ESTIMATES

Project: Bear Gulch Mine Complex

Client: USDA Forest Service, Region 1

ASSUMPTIONS:

- Repository is located either adjacent to Bear Top/Orofino Mill Site or a central location in Prichard/Beaver drainage (Site C)
- Backfill is available from a borrow area adjacent to repository Site C
- Topsoil must be produced by amending backfill with compost (180,000 lb compost /ac for 4-inch mixing depth for cost estimating purposes only)

UNIT COSTS USED FOR ALTERNATIVES ANALYSIS

ITEM	UNIT	COST	SOURCE
GENERAL			
Clearing and Grubbing	ac	$1,875.00	Winning contractor bid for Armstrong, Justice, Beatrice mine reclamation
Remove and Dispose of Debris	ton	$250.00	Engineer's estimate
Fence	lf	$5.00	Montana abandoned mine reclamation projects, typical
SEDIMENT CONTROL			
Install/Remove Silt Fence	ft	$1.04	2002 Means - Install x 1.5
Install/Remove Straw Bales	ft	$3.99	2002 Means - Install x 1.5
Install/Remove Temporary Culverts	ft	$36.00	Costs Derived using method from Armstrong, Justice and Beatrice Mines EE/CA, June 1999
PROTECT HISTORIC FEATURES			
Structures	ea	$500.00	Engineer's Estimate
ROAD UPGRADES			
Minor Upgrades to FS Roads	mi	$2,000.00	Idaho Lakeview Mine Cost Estimate
Major Upgrades to FS Roads	mi	$6,500.00	Idaho Lakeview Mine Cost Estimate
ROAD CONSTRUCTION			
Topsoil Stripping and Stockpiling	cy	$1.60	Idaho Lakeview Mine Winning Bid
Dozer Excavation/Motor Grading	mi	$3,584.00	Winning contractor bid for Armstrong, Justice, Beatrice mine reclamation
Bridge Removal and Culvert Installation (72X55 inch arch pipe)	ft	$181.25	Idaho Lakeview Mine Winning Bid x 1.25
Culvert Removal/Installation (24 inch pipe)	ft	$30.00	Idaho Lakeview Mine Winning Bid
Road Closure - Typical USFS Lockable Gate	ea	$1,400.00	Idaho Lakeview Engineer's Estimate for Stock Gate x 2
Temporary Bridge Installation/Removal (Contractor Furnished)	ls	$12,500.00	Engineer's Estimate
CLOSE OPEN ADITS and STOPES			
Close Open Adit Using Bat Grate	ea	$2,800.00	Average of 2000 Sel. Source Resp. Action Eng. Estimate and Prichard Winning Bid
Close Small Stope Using Poly Foam	cy	$75.00	Engineer's Estimate
Close Large Stope Using Poly Foam	cy	$65.00	Engineer's Estimate
CONSOLIDATION SITE CONSTRUCTION			
Topsoil Stripping and Stockpiling	cy	$1.60	Idaho Lakeview Mine Winning Bid
Excavate Subsoil in Footprint	cy	$2.20	Idaho Lakeview Mine Winning Bid
Compact Subgrade	cy	$0.78	2002 Means
Place and Compact Waste	cy	$2.94	2002 Means
Grade and Shape Waste	cy	$5.90	2002 Means
Replace Subsoil and Topsoil	cy	$8.75	2002 Means
Construct Runon and Runoff Control Ditches	ft	$5.28	2002 McLaren Pit Repository Engineer's Estimate for Type 7 Channel
Fertilize, Seed and Mulch	ac	$4,000.00	2000 Selective Source Response Action
Erosion Control Blanket	ac	$4,840.00	2000 Selective Source Response Action

SUMMARY OF ITEM UNIT COSTS FOR REMOVAL COST ESTIMATES

Project: Bear Gulch Mine Complex

Client: USDA Forest Service, Region 1

ASSUMPTIONS:

- Repository is located either adjacent to Bear Top/Orofino Mill Site or a central location in Prichard/Beaver drainage (Site C)
- Backfill is available from a borrow area adjacent to repository Site C
- Topsoil must be produced by amending backfill with compost (180,000 lb compost /ac for 4-inch mixing depth for cost estimating purposes only)

UNIT COSTS USED FOR ALTERNATIVES ANALYSIS

ITEM	UNIT	COST	SOURCE
REPOSITORY CONSTRUCTION			
Topsoil Stripping and Stockpiling	cy	$1.60	Idaho Lakeview Mine Winning Bid
Excavate Subsoil in Footprint	cy	$2.20	Idaho Lakeview Mine Winning Bid
Compact Subgrade	cy	$0.78	2002 Means
Place and Compact Waste	cy	$2.94	2002 Means
Grade and Shape Waste	cy	$5.90	2002 Means
Provide and Install Geosynthetic Clay Liner	sy	$5.40	2000 Selective Source Response Action
Provide and Install Geomembrane	sy	$5.40	2000 Selective Source Response Action
Replace Subsoil and Topsoil	cy	$8.75	2002 Means
Construct Runon and Runoff Control Ditches	ft	$5.28	2002 McLaren Pit Repository Engineer's Estimate for Type 7 Channel
Fertilize, Seed and Mulch	ac	$4,000.00	2000 Selective Source Response Action
Erosion Control Blanket	ac	$4,840.00	2000 Selective Source Response Action
SURFACE WATER DIVERSION			
Install Diversion Berm	ls	$3,500.00	Engineer's Estimate
Install Diversion Pipe (24" dia. SDR 21 HDPE)	ft	$43.00	Idaho Lakeview Mine Winning Bid
Construct Sediment Basin Berm	ea	$3,000.00	Engineer's Estimate
WASTE REMOVAL			
Excavate, Load and Haul Tailings to Consolidation Site	cy	$5.30	2003 Means
Excavate, Load and Haul Tailings/Waste Rock to Central Repository	cy	$20.19	2003 Means
BACKFILL			
Load, Haul, Place and Compact with full trip	cy	$20.19	2002 Means
Load, Haul, Place and Compact with half trip	cy	$15.34	2002 Means
PRODUCE TOPSOIL			
Amend Backfill With Compost	ac	$4,975.00	Engineer's Estimate
STREAM RECONSTRUCTION - BEAR GULCH			
Rebuild Streambanks and Streambed	ft	$45.00	Engineer's Estimate
ADIT DISCHARGE			
French Drain	ea	$1,000.00	Engineer's Estimate
Adit Discharge Infiltration Basin	ea	$4,000.00	Winning contractor bid for Armstrong, Justice, Beatrice mine reclamation
RECLAMATION OF DISTURBED AREAS			
Road obliteration	mi.	$2,000.00	Costs Derived for Armstrong, Justice and Beatrice Mines EE/CA, June 1999
Regrade all disturbed areas	ac	$2,420.00	Costs Derived for Armstrong, Justice and Beatrice Mines EE/CA, June 1999
Fertilize, Seed and Mulch	ac	$4,000.00	2000 Selective Source Response Action
Prepare Planting Areas and Plant Native Trees and Shrubs on Waste Rock Dumps	ea	$70.00	Engineer's Estimate
Revegetate Streambanks (both sides)	ft	$10.00	Engineer's Estimate